BRITISH

FRESH-WATER ALGÆ.

3

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EXCLUSIVE OF

DESMIDIEÆ AND DIATOMACEÆ.

With Coloured Plates.

BY

M. C. COOKE, M.A., LL.D., A.L.S.,

Author of "Handbook of British Fungi," "Mycographia," "Illustrations of British Fungi," &c., &c.

WILLIAMS AND NORGATE,
HENRIETTA STREET, COVENT GARDEN, LONDON;
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I. PALMELLACEÆ.

WILLIAMS AND NORGATE,
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Algæ are usually associated under five classes, which are taken in variable order, according to the judgment of the author, and may thus be enumerated :—

I. Chlorophyllophyceæ, with the cell contents mostly of a chlorophyll green.

II. Phycochromophyceæ, with the cell contents mostly of a bluish green.

III. Melanophyceæ, with the cell contents olive, brownish, or blackish.

IV. Rhodophyceæ, with the cell contents rosy, purple, crimson or violet.

V. Diatomophyceæ, with an incombustible siliceous skeleton.

Other arrangements have been proposed, but the above will answer for all practical purposes. The third class are all marine, and the majority of the fourth, so that, exclusive of Diatoms, which are a special study, the fresh water Algæ are mainly included in the first two classes.

Class I. CHLOROPHYLLOPHYCEÆ.

Plants aquatic or aërial, one, or two, or many-celled, either single or associated in families. Either branched or simple. Cell wall not siliceous but combustible, sometimes composed of successive layers, or strata, of a gelatinous substance. Cell contents chlorophyllose, sometimes crimson, flesh-coloured or reddish-brown, often with a central or lateral nucleus. Starchy granules very rare. Vegetation by cell division. Fecundation often sexual. Propagation either by oospores or zygospores or gonidia, which are motionless or agile (*zoogonidia*).—*Rabh. Alg.* iii. *p.* 1.

* Exclusive of Desmidieæ and Diatomaceæ.

ORDER I. *COCCOPHYCEÆ.*

Unicellular algæ. Cells either single, or many associated in families, tegument involute or naked, destitute of branches or terminal vegetation. Propagation by cell-division or zoogonidia.

This order includes the two families *Palmellaceæ* and *Protococcaceæ*, with unmoveable cells, to which is attached a third, the *Volvocineæ*, with mobile cells. The two former correspond to the *Chroococcaceæ* amongst the class *Phycochromaceæ*. Although thus removed, it would seem from recent researches, that there is, in some sort, a relationship between the *Palmellaceæ* and *Protococcaceæ* on the one hand, and the *Chroococcaceæ* on the other.

We can only direct attention here to the papers by P. Richter, in "Hedwigia,' (xix., 1880, p. 154) on *Glæocystis* and (xix. 1880, p. 169 and 191), on the "genetic Connection of certain Unicellular *Phycochromaceæ*," of which abstracts were published in the "Royal Microscopical Journal."*

The conclusions arrived at are in favour of a sort of polymorphism.

"The lowest form of the Phycochromaceæ is the naked *Aphanocapsa* condition, corresponding to *Palmella* among the Chlorophyllophyceæ. From this naked or only slightly encysted condition is developed the *Glæocapsa* or *Glæocystis* form with several gelatinous envelopes; the *Chroococcus* type, when the investment is altogether wanting, or, when there is only a single vesicular envelope, the cænobium types. The *Glæocapsa* type is specially adapted for exposure to the air, and growth upon a comparatively dry substratum; the cænobium type is developed in water; the *Chroococcus* type in water, or on a moist substratum in the air. With this is connected the cylindrical form, a higher stage, because it displays a differentiation in the direction of growth, and a development towards the filiform condition. This is not always developed, and may be distinguished into stable and unstable forms; the latter may occur in two or three varieties, and may go through the following successive conditions :—

1.—Stable *Aphanocapsa* and *Palmella*.

FAMILY I. PALMELLACEÆ.

Unicellular algæ, in the broadest sense. Cells either solitary, or more or less numerous, associated in families, vegetating by cell-division, propagation by gonidia, which are produced from the ultimate generation of cells. Gonidia, when free, ciliate (usually with a pair of cilia) actively mobile.

GENUS 1. **EREMOSPHÆRA.** *De Bary.* (1858.)

Cells single, rather large, swimming free, spherical, cell wall firm, with a hyaline border. Cell contents (*Cytioplasma*) green, granulose, sometimes containing green lamina disposed in a radiate manner. Multiplication of the cytioplasm by division into two or four (or more) sister cells, which escape by the rupture of the cell-wall (*Cytioderm.*)

Eremosphæra viridis. *DeBy. Conj. p.* 56, *t.* viii. *f.* 26, 27.

Cells globose, large, of a beautiful grass green.—*Rabh. Alg.* iii. *p.* 24.

Chlorosphæra Oliveri, Henfr. Trans. Micr. Soc. vii. p. 25 (1859), pl. 3. Kirch. Alg. Schl. p. 115.

SIZE, ·0043-·0059 in. = ·11-·15 mm. (*Rabh.*), ·1-·12 mm. (*M.C.C.*).

In boggy ditches.

"The ordinary appearance of the plant is that of a large green globe, like a large spore, lying free in the water, or often gathered in loose groups upon decaying vegetable structures, such as leaves of *Sphagnum* contained in the water. The globe is a single simple cell, with a thin membranous coat surrounding a mass of usually green granular contents. Each cell produces two, or more rarely, four new ones."—*Henfrey.*

Plate I. Cells in various conditions, all magnified 400 diameters.

GENUS 2. **PLEUROCOCCUS.** *Meneg.* (1842.)

Cells segregated, globose (or angular from mutual pressure), with a central nucleus. Single or associated in small families which are either globose or cubical. Cell wall firm, often thick, even, hyaline. Cell contents homogenous green, or oily red. Multiplication of cells by division in alternate directions. Propagation by gonidia in proper cells (*Sporangia*).

Plants aquatic, or aërial.

**Species green.*

Pleurococcus vulgaris. *Meneg. Nost.* 38, *t.* 5, *f.* 1.

Cells variable in size, simple, binate or quaternate, or as many as 32 associated in families, aggregated in a crustaceous, powdery bright-green and somewhat gelatinous (when moist) stratum.

Size. Cells ·004-·007 mm.; fam. ·018 mm. (*Rabh.*), cells ·004-·006 mm. (C).

Rabh. Alg. iii. 24 ; Kirch. Alg. Schl. p. 115.

Protococcus valgaris, Kutz. Spec. p. 199.

Protococcus communis, Kutz. Tab. i., f. 3.

Pleurococcus communis, Desm. Exs. 1, 1203 ; ii. 603.

Hæmatococcus vulgaris, Hass. Alg. p. 333, t. 71, f. 5.

Chlorococcum vulgare, Grev. Sc. Cr., Fl. No. 262.

On the trunks of trees, moist walls, &c. Common everywhere throughout the year.

"Plant of a lively full green colour, spreading very extensively over the trunks of trees, and staining the fingers on the slightest touch. Granules very minute, exceedingly numerous, densely aggregated, and forming an uneven surface. They are perfectly free, semi-transparent, and adhere together in an opposite manner by fours."—*Greville.*

Plate II. fig. 1. *a*, natural size; *b*, cells × 400 diam.

Pleurococcus angulosus. (*Corda*) *Meneg. Nost. t.*4, *f.* 5.

Cells single, or 2-4, associated (64) in families, deep green, nestling in greenish, rather gelatinous stratum, cell-membrane thick, diaphanous.

Size. Cells ·007-·013 mm. (*Rabh.*).

Rabh. Alg. iii. 25. Kirch. Alg. Schl. p. 115.

Protococcus angulosus, Corda in Sturm Fl. ii. 18.

Microcystis angulosa, Kutz. Linnæa, viii. 374.

Protococcus palustris, Kutz. Tab. i., t. 4.

On the stems and leaves of aquatic plants.

In the Kew Herbarium copy of Rabenhorst's Algæ Exsicc, No. 327, under this name, only *Chroococcus turgidus* can be found, so that it is not quoted above.

Plate II. f. 2. Cells magnified 400 diam.

[redacted]

SIZE. Cells ·006-·0095 mm. (*Rabh.*).

Rab. Alg. iii. 27.

"*The chignon fungus.*" Dr. Tilbury Fox, in "Science Gossip," May 1, 1867.

On human hair used as "chignons."

This organism, which is included by Rabenhorst amongst Algæ under the above name, is rather a doubtful production, at least it seems to be a doubtful alga. The late Dr. Tilbury Fox examined it carefully in 1867 with the following results:—

"If you take a hair on which the parasite exists, and hold it between yourself and the light, towards the outer half you will see one or more, perhaps half-a-dozen, little dark knots, the size of pin points, surrounding the shaft of the hair; they are readily felt on drawing the hair through the fingers; they are somewhat difficult to detach. Under the microscope, with a quarter-inch objective, the mass will be seen to be made up of cellular bodies surrounding the hair. It will be seen that the mass has the appearance of a fungus growth, of which two distinct forms are here present, viz., mycelial or filamentose, and sporular or cellular. The hair is apparently healthy, and if the slide be pressed the mass will break away from the hair on either side, bringing away with it more or less of the cuticle, and leaving behind a healthy shaft. The cells are seen to be of various shapes and sizes. They are from 1-1000 to 1-3000 of an inch, many are like the 'torula' cells developed from *Penicilium*. Others are larger, undergoing division very actively. They may be subdivided into two, three, or four parts, or much more freely. This indicates the assumption by the parasite of an algal condition. (It is this form to which the name *Pleurococcus Beigelii* manifestly applies.)

"In watching the mass on the hair carefully, it is evident that a number of small cells become detached from the outer or sporular form, and at once move actively about. These small cells indicate an active growth by subdivision, and a fruitful source of propagation. Certainly this variety of fungus, so far described, is the most active growth I have come across in my researches, and I have been enabled to germinate it most successfully, so as to set all questions as to its nature completely at rest. Placed under favourable circumstances in water, the spores enlarge considerably, and the mycelial filaments increase also, but there is at this time to be observed a very remarkable occurrence, though not in all cases. Some of the large cells have become filled with smaller cells, and in others, in addition to these, processes have been put forth from the circumference of the walls in a radiating manner; in other cases the enlarged cells have two long cilia attached to them, by which they move about rapidly, whilst a part of the hair previous to this free from the fungus, has become dotted all over by minute cells similar to those seen in the interior of the larger ones.

"But more than this, I have observed most distinctly large cells filled with smaller cells, furnished with exceedingly delicate radiating processes, and putting forth pseudopodia. It will here be seen to have assumed the features of an amœboid body. Nothing could have been more distinct to myself, and those who were observing with me, than this peculiar form; and it seems to me that we have here a pretty complete history of the life of the fungus—namely, the sporular subdividing and assuming an algal form, which in turn becomes amœbiform, and furnishes ciliated cells that supply the earliest condition of the fungus, scattered over the hair." Further details, with illustrations are given in the memoir, of which the above is an abstract, to which the student is referred.

Plate II. f. 4. Cells magnified 400 diam.

** *Species red or brownish.*

Pleurococcus miniatus. (*Kutz*) *Näg. Einz. Alg. p.* 65.

Cells very variable in size, globose, usually single, rarely 2-4 in a family, seated on a broadly effused red stratum, which is more or less gelatinous. Cell-membrane rather thick, colourless, hyaline, contents oleaginous orange.

SIZE. Cells ·0037-·016 mm. (*Rabh.*), ·0035-·015 mm. (*Kirch.*).

Rabh. Alg. iii. p. 27. Rabh. Exs. 31, 368, 1777. Kirch. Alg. Schl. p. 115.

On the walls of conservatories, all the year.

This is one of the species in which Braun has observed the " skinning off " of the outer cell-membrane.

Nägeli ascribes the red colour occurring in many *Palmellaceæ*, partly as a normal, partly as an abnormal phenomenon, to the formation of an orange-coloured oil in the place of the chlorophyll.* Braun says that probably all these have the power of retaining their life a long time in the dried condition; in the above species at least, he is quite sure of it. The brownish-red colour often acquired by *Protococcus viridis* may probably be explained in the same way.†

Plate II. fig. 5. Cells magnified 400 diam.

Pleurococcus roseo-persicinus. *Rabh. Alg.* III., 28.

Aquatic. Cells unequal, cloudy, single or binate, tegument hyaline, collected on a thin, rather gelatinous peach-rose coloured stratum.

SIZE. Cells ·0015-·004 mm.

Protococcus roseo-persicinus, Kutz. Tab. i. t. i.

Clathrocystis roseo-persicinus, Cohn, Beitr. iii. (1875), t. 6, f. 1-10.

Investing submerged aquatic plants.

This very minute species, with cells of a peach colour, is not uncommon about the *débris* of decaying plants in pools. The cells are usually agglomerated in spherical or elliptical masses. Certainly not a

SIZE. Cells ·009-·012 mm., fam. ·043-·09 mm. (*Rabh.*).
Rabh. Alg. iii. p. 29. Kirch. Alg. Schl. p. 112, partly.
Gleocapsa ampla, Kutz. Sp. p. 216. Tab. 3, f. 3.
Pleurococcus superbus, Cienk. Bot. Zeit., 20 Jan., 1865, p. 21. Archer Micr. Journ., 1866, p. 63.

Fixed to submerged plants.

Braun states that he has observed an irregular bursting and peeling off of the outer coat of multicellular families or sometimes of isolated cells surrounded by manifold coats in this species, and *G. vesiculosa*.*

Plate III. fig. 1. Cells magnified 400 diam.

Glæocystis vesiculosa. *Näg. Einz. Alg. p.* 66, *t.* 4.

Thallus gelatinous, green; cells small, globose, as many as 64, and more, associated in families; tegument hyaline, colourless, lamellose, lamellæ often breaking up; contents green, delicately granular.

SIZE. Cells ·0045-·0075 mm.; fam. ·036 mm. (*Rabh.*).
Rabh. Alg. iii., 29. Rabh. Exs., No. 707.
Glæocystis ampla var. *vesiculosa*, Kirch. Alg. Schl. p. 112.

On wood and stones in stagnant water.

In character this species resembles the last, but the cells are smaller. See also Ciënkowski's paper in "Botanische Zeitung" for 20 January, 1865, where this species is figured to the same scale as *Glæocystis ampla*.

Plate III. fig. 2. Cells magnified 400 diam.

Glæocystis rupestris. (*Lyngb.*) *Rabh. Alg.* III., 30.

Thallus more or less expanded, dirty green, gelatinous, rather firm; cells globose, middle-size, associated in families; tegument colourless, pellucid, distinctly lamellose, soon diffluent; contents green, granular; sporangia globose, containing from 4-12 gonidia.

SIZE. Cells ·0037-·005 mm.; fam. ·06 mm.; sporang. ·085 mm. (*Rabh.*).
Rabh. Krypt. Fl. Sachs. p. 128. Rabh. Exs. 1790. Kirch. Alg. Schl. p. 112.
Palmella rupestris, Lyngb. Hyd. 207, t. 69. Hook. Eng. Fl. v. p. 397.

On rocks, moist walls, and damp earth.

"It occurs as a dirty yellowish gelatinous crust often hanging down in flakes from the face of the rock."—*Carm.*

This is *not*, or only in part, the *Hæmatococcus rupestris*, Hassall (p. 326, t. 82, fig. 1), which is chiefly applicable to *Glæocapsa polydermatica*, K.

Plate VIII. fig. 1. Cells magnified 400 diam. *a*, from wet rocks; *b*, from damp earth.

* See Braun, "Rejuvenescence," Ray Society, p. 182.

Glæocystis botryoides. *Ktz. Phy. Gen. p.* 173.

Thallus gelatinous, soft, sticky, green ; cells minute, globose and oblong, associated in small families; tegument colourless, indistinctly lamellose, contents green.

SIZE. Cells ·002-·004 mm.; families ·01-·018 mm.

Glæocapsa botryoides, Kutz. Tab. 1, t. 20.

On wood, submerged or constantly wet.

Plate III. fig. 3. Cells magnified 400 diam.

** *Flesh-coloured, becoming reddish.*

Glæocystis Paroliniana. (*Meneg. Nost. t.* 10, *f.* 2.)

Thallus crustaceous, cartilagineous (horny when dry), about a line thick, flesh colour; cells small, sphærical, 2-4-8 associated in families; tegument very broad, distinctly concentrically lamellose ; contents becoming yellowish, granulose.

SIZE. Cells ·0037-·005 mm.; families ·24 mm. (*Rabh.*).

Rabh. Alg. iii. 30.

Microcystis Paroliniana, Meneg. Nost. p. 78.

Glæocapsa Paroliniana, Kutz. Tab. i. 36, f. 5.

On rocks constantly wet.

Collected some years ago in Kent by Rev. M. J. Berkeley, and usually found near the sea.

Plate III. fig. 5. Cells magnified 400 diam.

Glæocystis adnata. (*Huds.*) *Näg.*

Thallus broadly expanded, gelatinous, firm, yellow-brown; cells globose, or oblong; contents brownish-green or brown, granular; tegument colourless, pellucid, lamellose.

SIZE. Cells ·008-·013 mm. (*Rabh.*).

[redacted]

Genus 4. UROCOCCUS. *Hass.* (1845.)

Cells large, globose, or oblong, reddish or blood-red; tegument thick, gelatinous, concentrically lamellose; stem thick, gelatinous, often ringed or annulate.

All the species in this genus are rare, and with one exception confined to Britain. We are, therefore, compelled to reproduce figures already published, without measurements or information beyond the original descriptions.

The peculiar structure of the pedicellate cells is thus described by Braun:—"The large globular brownish-red or blood-red cells throw off colourless layers of cell membrane, which appear to be separated by intermediate layers of softer jelly, whence arises a distinctly concentric structure of the envelope. But the enveloping layers of *Urococcus* do not retain their original form and integrity; not increasing themselves in size, they are pushed off on the upper side by constantly succeeding inner coats, being at first merely attenuated at one side, but subsequently, as it seemed to me, actually broken through. Since this emergence from the old coats is always repeated on the same side, a membranous-gelatinous peduncle is produced formed of cups fitted one into another, so as to give an annularly streaked, apparently shortly articulated aspect. The red cell, which occupies the summit of this peduncle, sometimes divides, and this of course produces a subsequent dichotomy of the peduncle. If the periods of the formation of the separate enveloping layers were known, the age of the little plant, whose history is preserved in the gelatinous peduncle, might be determined by the number of rings."—*Rejuvenescence*, p. 179.

* *Stem annulate.*

Urococcus Hookerianus. *Hass. Alg. t.* 80, *f.* 4.

Cells globose, or elliptic, variable in size, blood-red, granular, stem more or less elongated, often divided, densely ringed.

Size. Cells ·013-·06 mm. (*Rabh.*).

Rabh. Alg. iii. 31.

Hæmatococcus Hookeriana, Berk. & Hass. in Hass. Alg. p. 325, t. 80, f. 4.

On chalk cliff, &c.

Plate IV. fig. 1. *a*, cells considerably magnified, after Hassall; *b*, cells further magnified, after Rabenhorst.

Urococcus insignis. *Hass. Alg. t.* 80, *f.* 6, *a. b.*

Cells large, globose, blood-red; stem abbreviated, remotely annulated.

Rabh. Alg. iii. p. 31.

Hæmatococcus insignis, Hass. Alg. p. 324.

"This very fine species I have never met with in any considerable quantity. Scattered isolated globules I have frequently met with, and these occasionally attached to a closely corrugated or ringed mucous appendage. Each globule is usually surrounded by a single vesicle or ring; in some globules, however, there are as many as four or five enclosing vesicles."—*Hassall.*

Plate IV. fig. 2. *a, b*, cells considerably magnified, after Hassall.

** *Stem without rings.*

Urococcus Allmanni. *Hass. t.* 80, *f.* 3.

Cells elliptical, blood-red; stem short, rather club-shaped, colourless, smooth.

Rabh. Alg. iii. p. 322.

Hæmatococcus Allmanni, Hass. Alg. p. 322.

In springs at Knaresborough.

Plate IV. fig. 3. *a*, cells considerably magnified, after Hassall; *b*, cells further magnified.

Urococcus cryptophilus. *Hass. t.* 80, *f.* 1.

Cells small, oval, rarely globose; tegument very large, confluent with the short ringless stem.

Rabh. Alg. iii. p. 32.

Hæmatococcus cryptophila, Hass. Alg. p. 324.

Hæmatococcus sanguineus, Harv. Man. p. 181.

Palmella cryptophila, Carm. in litt.

On stalactites lining a cavern in a quartz rock.

"Forms wide patches externally of a brick-red colour, but within whitish, breaking up easily into the numerous separate portions of which each mass is formed. The colour resides alone in the granules; these terminate the superior extremity of the mucous prolongations, which are colourless, and arranged almost entirely side by side. The granules or cells are several times smaller than in *U. Allmanni*."—*Hassall.*

Plate IV. fig. 4. *a*, cells considerably magnified, after Hassall; *b*, cells further magnified.

GENUS 5. **SCHIZOCHLAMYS.** *Br.* (1849.)

Cells globose (or ovate), either single, or 2-4 associated in families; tegument lamellose, as age advances dividing regularly

rating immediately into two cells, without previously acquiring a coat of cell-membrane, and therefore without skinning."—*Braun Rejuvenescence, p.* 181.

Schizochlamys gelatinosa. *Br. in Kutz. Sp. p.* 891.

Cells globose ; contents green, granulose.
SIZE. ·01-·0135 mm. (*Rabh.*).
Kutz. Tab. vol. vi. t. 70. Braun Rejuvenescence t. 2, f. 43-50. Rabh. Alg. iii. 32. Rabh. Exs. No. 103.

In peaty swamps, moor pools, and boggy ditches.

Plate III. fig. 6. Cells magnified 400 diam.

GENUS 6. **PALMELLA.** *Lyngb.* (1819.)

Cells globose, oval, or oblong, surrounded with a more or less thick integument, generally very soon confluent into a firm or soft jelly. Thallus shapeless. Division of the cells alternately in all directions.

* *Mostly green.*

Palmella mucosa. *Kutz. Phyc. Gen. p.* 172.

Thallus expanded, gelatinous, deformed, olivaceous-green ; cells large, nearly equal, pale green, delicately granular ; tegument very thin, soon diffluent.
SIZE. Cells ·015 mm. (*Rabh.*), ·007-·014 mm. (*Kirch.*).
Rabh. Alg. iii. 33. Kirch. Alg. Schl. p. 110.
Merettia mucosa, Trevis. Alg. p. 46.

On stones in streams.

Plate V. fig. 1. Portion of thallus with cells magnified 400 diam.

Palmella hyalina. *Breb. Alg. Fal. p.* 39.

Thallus gelatinous, irregularly expanded, green ; cells very minute, crowded ; tegument almost homogenous with the gelatinous thallus, very soon diffluent.
SIZE. Cells ·0005-·001 mm. (*Rabh.*), ·00075-·001 mm. (*Kirch.*).
Rabh. Alg. iii. 33. Rabh. Exs. 1525. Kirch. Alg. Schl. p. 110.
Coccochloris hyalina, Meneg. Nost. p. 66.

In stagnant water, and bogs.

The species called *Coccochloris hyalina* by Hassall (p. 315) is *Homalococcus Hassallii*, Kutz., one of the *Phycochromophyceæ*, and not the present. Perhaps the two may have been mixed up.

Plate V. fig. 3. *a*, part of thallus, × 400 ; *b*, portion × 800 diam.

Palmella Mooreana. *Harv. Man. p.* 178.

Thallus irregularly globose, tuberculate, dark green, gelatinous, firm. Cells nearly equal, pale green.

SIZE. Cells ·008 × ·005 mm.

Rabh. Alg. iii. p. 34.

Coccochloris Mooreana, Hass. Alg. 316, t. 78, f. 1.

In bogs and stagnant water.

"The fronds are of an irregular globose form, about an inch in diameter, tuberculated, and inclining to become hollow in the centre when old, at which time it floats on the surface; the colour is dark-green and the substance firm, resembling that of an animal's liver."—*Moore.*

We found this species floating freely in a pond in Sutton Park, Birmingham. In this condition it has just the appearance and texture of a *Nostoc.* Is it distinct from *Aphanothece prasina ?*

Plate V. fig, 4. *a,* plant natural size; *b,* portion × 400 diam.

*****Reddish or orange.***

Palmella miniata, var. **æqualis.** *Näg. Einz. Alg. t.* 4, D. 2.

Thallus expanded, soft, amorphous, brick-red; cells nearly equal, tegument somewhat thick, colourless, hyaline, indistinctly striate; contents orange, sometimes greenish.

SIZE. Cells ·012-·014 mm.

Rabh. Alg. iii. 34. Rabh. Exs. No. 1778.

Sorospora grumosa, Hass. Alg. p. 310, t. 80, f. 7. ?

On wet rocks, moist ground, &c.

We are of opinion that this is the *Sorospora grumosa* of Hassall. The typical form of *Palmella miniata* has very minute cells, not exceeding ·0035-·004 mm., but this variety, if it be not a distinct species, has cells nearly four times as large.

Plate V. fig. 2. Portion of thallus, magnified 400 diam.

Palmella prodigiosa. *Mont. Comptes Rend.* 1852, 119.

[redacted]

boiled vegetables, or even decaying Agarics, is quite astonishing, making them appear as if spotted with arterial blood; and what increases the illusion is, that there are little detached specks, exactly as if they had been squirted in jets from a small artery. The particles of which the substance is composed have an active molecular motion, but the morphosis of the production has not yet been properly observed, and till that is the case it will be impossible to assign its place rightly in the vegetable world. Its resemblance to the gelatinous specks which occur on mouldy paste, or raw meat in an incipient state of decomposition, satisfy me that it is not properly an Alga." Mr. H. O. Stephens, on the other hand, contends that it is an Algoid production. After narrating its history (see "Ann. Nat. Hist.," 1853, p. 409), he says—"I observed at table the under surface of a half-round of boiled salt beef, cooked the day before, to be specked with several bright carmine-coloured spots, as if the dish in which the meat was placed had contained minute portions of red currant jelly. On examination the next day, the spots had spread into patches of a vivid carmine-red stratum of two or more inches in length.

" With a simple lens the plant appears to consist of a gelatinous substratum of a paler red, bearing an upper layer of a vivid red hue, having an uneven or papillate surface. The microscope shows this stratum to consist of generally globose cells immersed in or connected by mucilaginous or gelatinous matter. The cells vary in size, and contain red endochrome. As far as I can observe they consist of a single cell-membrane, and contain a nucleus. Treated with sulpho-iodine, they become blue. In my judgment this plant is a *Palmella* closely allied to *P. cruenta*, but certainly distinct, the cells or granules of the latter differing from it not only in their colour but size." The memoir also contains observations on the great vitality of this species, and other subjects connected therewith, to which the student is referred.

Plate V. fig. 5. *a*, part of thallus, magnified 400 diam.; *b*, portion magnified 800 diam.

GENUS 7. **PORPHYRIDIUM.** *Näg.* (1849.)

Thallus between gelatinous and membranaceous, somewhat incrusting, long and broadly expanded, composed of globose or many-sided cells. Multiplication of the cells by alternate division in all directions. Propagation unknown.

This genus is placed by some authors in *Porphyraceæ*, near the genus *Bangia*, in the class *Rhodophyceæ* (see Rabh. Alg. iii. 397), but we prefer to retain it near the old genus *Palmella*, in which it was previously included, and to which it seems to be most naturally allied.

Porphyridium cruentum. *Näg. Einz. Alg. t.* 4 H.

Thallus dark purplish-red, gelatinous; cells angular or rounded.

SIZE. ·007-·01 mm. (*Rabh.*), ·0065-·009 mm. (*Kirch.*).

Kirch. Alg. Schl. p. 111. Rabh. Alg. iii. 397.

Palmella cruenta, Ag. Syst. p. 15. Rabh. Exs. No. 14 and 1071. Hass. Alg. p. 308, t. 80, f. 5.

Tremella cruenta, Eng. Bot. t. 1800. Grev. Sc. Crypt. Fl. pl. 205.

On the naked ground, moist walls, &c. Common throughout Europe.

The red spots are at first rounded, then irregular, soon confluent, and form an expanded crust, like coagulated blood of a deep purple colour.

Plate V. fig. 6. *a*, plant natural size; *b*, cells magnified 400 diam.

GENUS 8. **BOTRYDINA.** *Breb.* (1839.)

Cells oblong or rounded, involved in a very thick, gelatinous, partially diffluent integument, in large families, which are often very numerous, enclosed in a mother cell which constitutes a subglobose thallus.

Only one species in this genus.

Botrydina vulgaris. *Breb. in Hass. Alg.* 320.

Thallus minute, rarely larger than the head of a pin, globose, green.

SIZE. Thallus from 1-500th to 1-10th mm.; cells ·002-·004 mm.

Meneg. Nost. p. 98, t. 13, f. 2. Rabh. Alg. iii. 37. Rabh. Exs. No. 388. Hass. Alg. p. 320, t. 81, f. 2. Kirch. Alg. Schl. p. 111.

On moist ground, trunks, moss, &c.

"The fronds of various sizes, rarely surpassing the head of a pin, of a subsphærical form, aggregated in considerable quantity, cover the stems of mosses with a pulverulent blackish-green stratum, which Agardh first well delineated. The granules, in the beginning solitary, here and there affixed, subsphærical, or slightly angular, scarcely equal in their greatest diameter 1-500th mm.; gradually they increase in size, and when they have arrived at the 1-200th mm. they manifest an internal granular substance; at a later period having acquired a form exactly spherical, the internal substance is seen aggregated or collected into the centre, and the granules surrounded by a pellucid margin. Again, they increase in size, and the interior granules are seen converted into vesicles filled with lesser granules. These vesicles increased in number and magnitude, the greatest dimensions of the frond [redacted]

Palmodictyon viride. *Kutz. Tab. Phy.* I. *t.* 31, *f.* 1.

Thallus mucous, irregularly reticulate, about the thickness of a hair, greenish; cells biserial, with a very thick homogenous tegument.

SIZE. Cells without tegument, ·0075-·009 mm., with the tegument ·025-·04 mm. (*Rabh.*).

Rabh. Alg. iii. 37. Kutz. Phy. Germ. p. 155.

In ditches, canals, &c., attached to stones, twigs, &c.

Recently found by Mr. E. Parfitt near Exeter, of which he gives the following account:—"The plant, where it has sufficient room to develope itself, spreads over the bottom, in water about six inches deep; beyond this it comes in contact with *Elodes canadensis*, over which it creeps, and extends its growth from branch to branch into deeper water. In this extension it has first the appearance of a *Conferva*, which I at first took it to be; but the moment I touched it, after taking some from the water, I found from the soft slimy feel that if a *Conferva* it was new to me, and the microscope soon revealed the true character. When the plant grows on the bottom it shows one continuous green membrane, stretched tight over the bottom, but when it comes in contact with other plants it throws out filaments, the thickness of which is difficult to make out on account of their adhesive nature; for wherever they touch it is matter of impossibility to separate them. The membrane forming the filaments is structureless, but the sphærical cells, which form more or less moniliform threads, sometimes running in parallel lines, at other times forming an irregular net-work on the inside of the filaments. These cells sometimes divide into two portions, at others into four, and in most of the mature cells may be observed four cellules."—*Grevillea*, iii., *p.* 29.

Plate VIII. fig. 2. *a*, portion magnified 200 diam.; *b*, fragment magnified 400 diam.

Palmodictyon rufescens. *Kutz Spec.* 234.

Is usually referred here on the faith of the remark by Kutzing, that it was found at Aberdeen by Dr. Dickie. Upon enquiry of Dr. Dickie we learn that he knows nothing of the species. He says, "*Palmodictyon rufescens* is unknown to me, many years have passed since I corresponded with Lenormand, and I do not remember receiving any note from him regarding it. Kutzing (Spec. 234) is responsible for the name. I cannot find in my collection anything so named, neither do I remember where the so-called material was collected." Under these circumstances it is useless repeating the name in connection with British Algæ.

GENUS 10. **TETRASPORA.** *Link.* (1810.)

Thallus gelatinous, membranous, or submembranous, in the beginning a short sac, afterward expanded; cells globose or angular, more or less distant, but associated in a single stratum into large families. Tegument thick, very rapidly diffluent into a homogenous mucous. Division in two directions in the same plane.

Tetraspora bullosa. *Ag. Sp. Alg. p.* 414.

Thallus membranaceous, saccate, obovate, sinuate, bullose, an inch to a palm long, dark green, more or less verrucose; cells nearly sphærical (after division hemisphærical or angular), geminate, or quaternate, crowded, granular.

SIZE. Cells before division ·008-·012 mm., after division ·0058-·0075 mm. (*Rabh.*).

Rabh. Alg. iii. 39. Rabh. Exs. No. 115, 1233. Kirch. Alg. Schl. p. 108.

Monotrema bullosum, Thur. Mem. Cherb. 1854.

Tetraspora minima, Desv. Flor. Ang. p. 17.

Ulva bullosa, Roth. Cat. iii. 320. Hook. Brit. Fl. ii. 312. Harv. Man. p. 171. Hass. Alg. t. 78, f. 13. Dickie Bot. Guide, p. 306. Eng. Bot. ed. 2, t. 2405.

Stagnant pools and ditches of fresh water.

Plate VI. fig. 1. *a*, natural size; *b*, fragment mag. 400 diam.

Tetraspora gelatinosa. (*Vauch.*)

Thallus vesiculose, ovate-clavate, or obovate, gelatinous, with age unequally expanded, irregularly torn, pallid and sometimes dirty-green, often incrusted with lime; cells of variable size, globose, either single or geminate, and scattered or quaternate, or geminate, and somewhat crowded; contents green and granular.

SIZE. Cells ·003-·014 mm. (*Rabh.*).

Rabh. Alg. iii. 40. Hook. Br. Flor. ii. 313. Mackay Flor. Hiber. p. 244. Hass. Alg. p. 301. Kirch. Alg. Schl. p. 109.

Ulva gelatinosa, Vauch. Hist. p. 244, t. 17, f. 2.

Rivularia tubulosa, DC. Fl. Fr. ii. p. 5.

In pools and ditches.

Plate VI. fig. 2. *a*, natural size; *b*, fragment mag. 400 diam.

"This species, at all events, would appear to be distinct, the cells being two to three times smaller than those of *T. lubrica* and *T. gelatinosa*."—*Hassall.*

This is a doubtful species, which no one but Hassall appears to have seen.

Plate VI. fig. 4. Fragment magnified, after Hassall.

GENUS 11. BOTRYOCOCCUS. *Kutz.* (1849.)

Thallus botryoid (or like a bunch of grapes), irregularly lobed, mucous, involved in a thin parent membrane (?). Cells ovoid or elliptic, united in families, which are densely packed within a thin diffluent tegument.

Represented in Europe by a single species.

Botryococcus Braunii. *Kutz. sp.* 892.

Small, free swimming, green, at length becoming pallid or reddish-brown.

SIZE. Cells ·01-·0125 mm. (*Rabh.*).

Rabh. Alg. iii. 43. Fres. in Abh. Senk. t. ii. f. 27-33. Archer Micr. Journ., 1870, p. 88. Kirch. Alg. Schl. p. 111.

In moor pools.

Specimens were found by Dr. Moore floating on the surface of Lough Bray in long sheets of some yards in length. Mr. Archer remarked upon these "that this was not an uncommon alga in moor pools, sometimes coating submerged sedges, and the like, with a greyish green stratum, sometimes, however, suspended in the water in streaks, and often isolated. It passes through a red condition. More than once, when a single group or family of this alga, from gatherings kept for some time in the house, had turned up under a low power of the microscope, he had been to some extent deceived by the way in which it resembles some radiolarian rhizopod, strange as it may seem. The mucous matrix containing the families of cells seems not unfrequently to give off rather long, filiform prolongations, which stand out more or less radiantly, looking not unlike pseudopodia and these are undoubted rhizopoda containing chlorophyll. It might, indeed, be a good example of two objects with no affinity in any respect to each other, still superficially simulating one another."—*Micro. Journ.*, 1870, *p.* 88.

Plate VII. fig. 2. *a*, family group; *b*, single family; *c*, undergoing segmentation; *d*, free mature cells. All magnified 400 diameters.

GENUS 12. APIOCYSTIS. *Näg.* (1849.)

Thallus small, vesicular, fixed by a stem-like base. Cells globose, scattered, or sometimes 8 disposed in a circle; contents homogenous, or delicately granulose, with a distinct colourless vacuole; tegument thick, dissolving into a homogenous gelatine, cells dividing alternately in all directions. Propagation by mobile gonidia, which are globose, and furnished with a pair of vibratile cilia.

This genus consists of a single species, unless the variety *linearis* of Nägeli is entitled to rank as specifically distinct.

Apiocystis Brauniana. *Näg. Einz. Alg. p.* 69.

Thallus pear-shaped, pallid green, the cavity filled up by gelatinous matter, in which are imbedded the gonidia, at first few, increasing in number with age, as far as 1600.

SIZE. Frond ·04-·1 mm. high, gonidia ·012 mm. diam., cells ·0075-·011 mm. (*Rabh.*).

Rabh. Alg. iii. 43. Fresen. Beitr. p. 237, t. ii. f. 1-20. Henfrey in Micro. Journ., 1856, p. 52, t. 4, f. 26-27.

Fresh water ditches, &c.

Professor Henfrey found this plant in January, in a jar of water containing aquatic plants brought from Wimbledon Common six months previously. The development, as recorded by Nägeli, is detailed in the article quoted above.

"The young 'swarm cells' (zoospores) attach themselves by their ciliated point (especially to *Cladophora fracta*), and become invested with a club-shaped, enveloping membrane. The first division of the green body then takes place in the direction of the axis of the vesicular envelope, and is repeated alternately in each direction of space. During this the vesicle in which the cells (gonidia) lie, continually expands, and generally becomes very evidently pedunculated. Young vesicles contain a regular number of cells, namely, 2, 4, 8, 16, 32, &c., but the number afterwards becomes indefinite; in largish vesicles, 1-50″ (·5 mm.) long and 1-120″ (·22 mm.) diam. I have counted about 300; in the largest, about 1-25″ (·1 mm.) long and 1-50″ (·5 mm.) thick, some 1,600 cells.

"The cells (gonidia) are at first uniformly distributed over the whole cavity of the vesicle. Subsequently they generally become collected on the internal surface of the wall of the vesicle, where they lie in one or more strata. But the cell division always takes place in all directions of space, the cells situated internally advancing outwards towards the periphery. In old vesicles the cells are sometimes arranged in rings of eight upon the wall. When the family of cells is mature for

[redacted]

GENUS 13. **RHAPHIDIUM.** *Kutz.* (1845.)

Cells fusiform, or cylindrical, generally very gradually cuspidate or acuminate at the ends, rarely obtuse, straight or variously curved, single, geminate, or fasciculately aggregate, decussate in the centre, or radiately conjoined, rarely two laterally united at the end, other cells free. Tegument thin, smooth. Contents green, very finely granular, furnished with a central, or rarely lateral, transparent vacuole. Division of the cells only in one direction.

Rhaphidium aciculare. *Braun. Rabh. Exs.* 442.

Very slender, 15-20 times as long as broad, yellow-green, often single, acicular, acutely cuspidate at each end, straight, or slightly curved or somewhat lunate.

Ankistrodesmus acutissimus, Archer in Micr. Journ., 1862, t. xii. f. 44-56.

Closterium Griffithii, Berk. Ann. Nat. Hist. xiii. 256, t. 14, f. 2.

Rhaphidium polymorphum var. *γ aciculare,* Rabh. Alg. iii. 45.

In pools.

"Cells very minute, 20-25 times longer than broad, fusiform, very slender, straight, very acutely acicular, solitary or forming fasciculi of 2-4 cells; endochrome light-green, mostly with a minute parietal semicircular or rounded pale body or space placed near the middle of the cell, otherwise usually appearing homogenous, sometimes slightly granular." It agrees with *R. falcatum* in its very slender and acute cells, but it differs from it by its straight, not arcuate cells, by its fusiform more quickly attenuated cells, by its more intensely acute extremities, and by the constituent cells of an old fasciculus being much fewer in number.—*Archer.*

Plate VIII. fig. 3. Cells magnified 400 diam.

Rhaphidium falcatum. *(Corda.)*

Fusiform, slender, acutely cuspidate at each extremity, curved, or semi-lunar, 4-16 congregated in fascicles.

Micrasterias falcata, Corda Alm. Carls. 1835, p. 121, t. 2, f. 29.

Staurastrum falcatum, Ehr. Weigm. Arch. 1836, p. 185.

Closterium falcatum, Meneg. Linnæa, 1840, p. 233.

Ankistrodesmus gregarius, Breb. in litt.

Ankistrodesmus falcatus, Ralfs Desm. t. 34, f. 3.

Rhaphidium polymorphum, var. c. *falcatum,* Rabh. Alg. iii, 45.

In pools.

It is a very common plant in ponds, &c., and resembles a minute young *Closterium,* except that although some individuals may be solitary, others will be seen in the same gathering collected in the characteristic fascicles.

Plate VIII. fig. 4. *a,* families magnified 400; *b,* magnified 800 diam.

Rhaphidium duplex. *Kutz. Phyc. Germ. p.* 144.

Fusiform, slender, slightly sigmoid, single, or 2, 3, or 4 laterally connected at the poles, otherwise free.

Rhaphidium triplex, Rabh. Krypt. Fl. Sax., p. 134.

Scenedesmus duplex, Ralfs Desm. 193, t. 34, f. 17.

Rhaphidium polymorphum var. d. *sigmoideum*, Rabh. Alg. iii. p. 45.

In pools (apparently rare).

"Cells linear-lanceolate; extremities tapering to a fine point and curved in opposite directions. The cells closely united, frequently the frond, consists of only a single pair of cells so connected, but sometimes of two or even three of these pairs, which, however, are remote from each other, in this case; as the connecting mucous is colourless, they look like distinct plants, and their relation can be detected only by moving the frond. If kept in water for a few days, the cells separate from each other."—*Ralfs.*

This description is scarcely accurate, as each cell is a distinct plant.

Plate VIII. fig. 5. *a*, cells magnified 400; *b*, magnified 800 diam.

GENUS 14. **DICTYOSPHÆRIUM.** *Näg.* (1849.)

Cells elliptic, with thick confluent mucous investment, combined in numbers into free-swimming one-layered hollow-globular families, one always at the ends of delicate threads which proceed from the central point of the family, and which become repeatedly branched towards the periphery; division at the commencement of a series of generations in all directions of space; afterwards, as regards the middle point of the aggregate family, as a rule, alternating only in the two tangental directions.

[redacted]

Dictyosphærium reniforme. *Buln. Hedwigia* II. 22.

Families aggregated in an irregular form; cells reniform, nearly twice as broad as long.

SIZE. Cells ·008-·009 mm. (*Rabh.*), ·006-·01 × ·01-·02 mm. (*Kirch.*).

Rabh. Alg. iii. 47. Rabh. Exs. 789. Archer in Micro. Journ., 1868, viii. p. 65. Kirch. Alg. Schl. p. 106.

In pools. Near Snowdon, N. Wales.

"This plant possesses larger families than *D. Ehrenbergianum*, which are irregularly shaped, seemingly owing to the development of the delicate supporting fibre not going on in the same regular manner as in the preceding species, and the cells themselves are much larger and reniform."—*Archer*.

Plate IX. fig. 2. *a, b,* plants magnified 400 diam.; *c*, portions showing filament.

Dictyosphærium constrictum, *Archer* (*Micr. Journ.*, 1866, p. 128) having been afterwards found to produce zygospores (see "Micro. Journ.," 1875, p. 415), has been transferred to the *Desmideæ* in company with *Cosmocladium*, to which genus it seems to be allied.

Cosmocladium Saxonicum, *DeBary*, is sometimes placed by authors (as in Rabenhorst's Algæ) in this family. But, as DeBary demonstrated in "Flora" (No. 21, 1865), the cells proceed in the same manner as in *Cosmarium*, and therefore its proper place is with the *Conjugatæ*, as one of the *Desmideæ*. It has been found in North Wales.

GENUS 15. **HORMOSPORA.** *Breb.* (1840.)

Thallus tubular, gelatinous, swimming free. Cells oblong, or oval, green, arranged in simple longitudinal series (families), either remote from each other, or more or less united at the poles. Tegument thick, confluent, contained within the broad gelatinous tube, which is either simple or branched.

* *Tubes simple.*

Hormospora mutabilis. *Breb. Mem. Fal.* 1840.

Tubes intricate, more or less broad, or parallel and coalescing; cells twice as long as broad, broadly rounded at each end; tegument very thin.

SIZE. Cells ·011-·017 mm., tube diam. ·043 mm. (*Rabh.*).

Rabh. Alg. iii. 48. Breb. in Ann. des Sci. Nat., 1844, t. i. f. 2. Kirch. Alg. Schl. p. 108.

In boggy pools. Ireland.

Plate X. fig. 1. *a*, portion of filament × 300; *b*, same breaking up × 300.

Hormospora transversalis. *Breb.*

Tubes slimy, equal or undulate; cells ovate-oblong or fusiform, disposed transversely in a moniliform series; contents granular.

SIZE. Diameter of tube ·075-·12 mm.

Rabh. Alg. iii. 49.

In bogs.

Plate X. fig. 3. *a*, portion of filament × 200 diam.; *b*, portion × 400 diam.

** *Tubes branched.*

Hormospora ramosa. *Thwaites.*

Tubes broad, gelatinous, irregularly branched; cells oval or nearly cylindrical, obtuse at the ends, either remote from each other or connected, twice as long as broad; contents green, with green laminæ radiating from the centre.

Thwaites in Harvey Phy. Britt. t. 213. Rabh. Alg. iii. 49.

In brackish and salt water, attached to *Cladophora.*

The filaments in this species, unlike those of the preceding two species, are branched.

Plate X. fig. 2. *a*, portion of filament × 200; *b*, small portion with cells × 400.

GENUS 16. **CYLINDROCAPSA.** *Reinsch.* (1867.)

Cells sphærical or ellipsoid, membrane thick, either with a three or fourfold tegument, or naked; cells associated in a linear series in families, enclosed in a cylindrical hyaline gela-

[redacted]

plant agreed with Reinsch's in the dimensions of the cells, their oval figure (truncate after division, whilst closely apposed, and until full size is again attained), their longer diameter posed in the direction of the length of the cylindrical filament and in their being involved by a number of concentric hyaline investments standing off from the cells at the poles, closely applied at the sides; not, however (as Reinsch shows) uniformly *four*, but two, three, or four, and standing off from the cells, not equidistantly, but at different distances. It is, however, quite possible that where the fewer number only of laminæ of the envelopes were apparent, others may have been present, but so closely applied to the cells (and to each other) as to appear as if absent. Just as depicted by Reinsch (though his figure be rather stiff), I saw some of the cells undergoing self-division, the fission always taking place through the shorter diameter, the new cells, at first flattened at the ends, then growing as long as the older, and becoming rounded off, and thus the longitudinal direction of the cells is maintained. Thus this form is unlike *Cylindrocapsa nuda* (Reinsch), in which the oval cells are placed transversely, and appear to be without the loose outer envelopes. The author does not state that the contents are not a bright, but a dull lurid green, very opaque. On endeavouring to preserve this plant, it 'kept' not at all, colour became lost, envelope shrivelled, and even after a couple of days the examples did not represent the same thing as when fresh.

"Thus the morphology of the plant points to an affinity with *Hormospora*, Breb., which, too, has its forms with the elliptic cells placed longitudinally (*H. mutabilis* and others) and transversely (*H. transversalis*), but no *Hormospora*, except *H. ramosa*, Thwaites, appears attached; the contents, too, are bright green, and seem to show a characteristic internal arrangement not seen in *Cylindrocapsa;* the outer investment is also more mucous. As a form, or a form-species, (for, doubtless, such as those belonging to *Cylindrocapsa* and *Hormospora* can all be accounted no more, so long as no reproductive process is known) the present plant (*Cylindrocapsa involuta*) is, *per se*, abundantly distinct. It appears to be very rare, so does *C. nuda*, which I only once met with; neither is recorded by Rabenhorst in 'Flor. Europ.'

"But whether these *Cylindrocapsa-forms* be mere stages of other growths—mere form-species—or permanent parthenogenetic species—they are entitled to hold a place for purposes of reference until happily more be, if ever, known as to their development and their right to rank as independent plants."—*Grev.* III. 40.

Plate IX. fig. 3. Portions showing spores × 400 diam.

Cylindrocapsa nuda. *Reinsch Alg. p.* 67, *t.* 6, *f.* 2.

Undivided cells ellipsoid, membrane thick, without teguments, filaments now and then thickened and enclosing four cells.

SIZE. Tube ·023-·03 mm. diam.

In streams. Ireland.

Cienkowski's* researches on *Cylindrocapsa involuta* achieved such important results that they must be indicated here, since the reproduction will, doubtless, be identical in both species.

"This alga possesses antheridia and oogonia. The oogonium is a globular inflated joint, it consists of contents and wall; the first presents

* Cienkowski, "Zur Morphologie der Ulotricheen," in Melanges Acad. Imp. de St. Petersburg, t. ix. p. 531.

a protoplasmic gonosphere, coloured by chlorophyll, containing numerous starch granules; it presents at one point of the periphery very often a clear spot. The gonosphere is loosely enclosed by the several (3-6) concentric gelatinous (as it were swollen or expanded) membranes. Such oogonia lie either several together, forming a moniliform chain, or they present themselves in the middle of a series of antheridia, or between unaltered vegetative joints, upon which, further on, may abut antheridia. *Cylindrocapsa* is thus monoicous. At both poles of the oogonium the coats are produced into a short cylindrical process; adjoining processes are mutually apposed. The size of the oogonia varies; it may reach ·042 mm., the gonosphere ·024 mm.

"The antheridia are discoid or sphæroidal little cells, like the oogonia possessing a multi-laminated coat, they may form a long series or little groups of pairs; they are often enveloped in twos or fours by numerous laminæ. The contents are clear reddish yellow. The male cells (like the vegetative) are formed by binary division of the mother joint, with the distinction that they cease to grow, remain smaller, and gradually assume the yellowish red colour. Each antheridium developes by division of its contents two spermatozoids. At maturity they are ejected with a jerk; when free, they lie for a while motionless enclosed in their gelatinous envelope. Presently they assume a tremulous motion, at last bursting the vesicle and swimming about. They are protoplasmic fusiform bodies of about ·015 mm. in length, contents sparing, yellowish red; at the anterior hyaline point are borne two flagella, below which are two minute pulsating vacuoles.

"Shortly after their exit they are to be found in the neighbourhood of the oogonia. The whole cavity of the oogonium becomes pushed out laterally, dissolving and leaving an opening at the apex of the expansion. The spermatozoids seem now to be no way aimless in their movements, their whole object being seemingly to effect a penetration; with great energy they drive against the wall, and retreat, and so persist for hours, until at last the movement ceases, and they shrink into formless little masses. The actual confluence of the spermatozoid with the gonosphere was not observed, but the conclusion drawn by the author seems to be legitimate.

"The next change consists in the appearance of a thick gelatinous stratum directly on the surface of the gonosphere, which soon hardens into a doubly contoured membrane. After some days the chlorophyll with

globose, afterwards elongated, or elliptic, sometimes conoid, one or other pole colourless, arranged more or less regularly in longitudinal families; tegument thick, at length diffluent, cells dividing in one direction, chiefly at the apex or periphery of the thallus. Propagation by means of agile gonidia.

Hydrurus penicellatus. *Ag. Syst. p.* 24.

Thallus rather cartilaginous, olivaceous, of variable thickness, simple and naked below, divided above, and villous with dense fibrils. Internal cells elliptical or somewhat lanceolate; tegument very thin, scarce visible; contents homogenous.

Rabh. Alg. iii. 50.

Hydrurus fœtidus, Vauch. Kirch. Alg. Schl. p. 106.

var. e. **Ducluzelii.** *Rabh. Alg.* III. 50.

Thallus from an inch to a foot long, oftentimes sparingly branched, plumose with very dense fibrils.

SIZE. Cells ·006-·0095 mm. (*Rabh.*).

Hydrurus Ducluzelii, Ag. Consp. p. 27. Hass. Alg. t. 77, f. 3. Rabh. Exs. 176, 873, 1193.

Batrachospermum myosurus, Ducluz. Conf. Montp. p. 76.

Palmella myosurus, Lyngb. Hydr. t. 68, E.

Cluzella myosurus, Bory. Dict. iv. 234.

In alpine rivulets, on stones, rocks, &c.

"Root scutate, blackish, hard. Fronds clustered, solid, very gelatinous, 2-6 inches long or more, 2-4 lines in diameter, freely waving in the water, attenuated towards the apex, branched; branches scattered, alternate, elongate. slender, beset with other more slender, short ramuli. Gelatinous mass pellucid, viscid, colourless under the microscope, without apparent margin, unless as the granules imbedded within its substance indicate such; these are globose, green, formed on the stem and primary branches, most densely set in the ramuli, especially towards the margin. Colour of the recent frond brownish-olive, or dark brown, in drying green; of the granules both recent and dry green."—*Lyngbye.*

Odour in a recent state very offensive.

One or other of the many forms of this species has been called *Palmodactylon subramosum*, Näg., but we have not, as yet, seen any true British representative of that genus.

Plate X. fig. 4. *a*, natural size; *b*, portion magnified 400 diam.

GENUS 18. **NEPHROCYTIUM.** *Näg.* (1849.)

Cells oblong kidney-shaped, with a dorsal chlorophyllose vesicle, 2-4-8-16 associated in free swimming families surrounded by an ample oval or kidney-shaped tegument. Propagation unknown.

Only two European species, both of which have been found in the British Isles. Both are usually found together, and it is possible that hereafter they may be referred back to one species, as Nägeli proposed.

Nephrocytium Agardhianum. *Näg. Einz. Alg. p.* 80.

Cells pale green, almost homogenous, 4-6 times as long as broad, spirally arranged, in families of 4-8 cells; tegument thin which encloses them, length 2-3 times the breadth.

SIZE. Cells diam. ·0038-·0075 mm. (*Rabh.*).

Rabh. Alg. iii. 52. Näg. Einz. Alg. (*forma minor*), t. iii. C. a-h. Kirch. Alg. Schl. p. 112.

In ditches, bogs, &c.

Plate XI. fig. 1. *a, b,* families; *c,* end view; *d,* free cells. All magnified 400 diam.

Nephrocytium Näegelii. *Grun. Rabh. Alg.* III. 52.

Cells dark green, granular, twice as long as broad, irregularly disposed, families usually composed of 16 cells; tegument thick.

SIZE. Cells diam. ·011-·022 mm. (*Rabh.*).

Nephrocytium Agardhianum, majus Näg. Einz. Alg. t. iii. C. fig. i, k, p. Kirch. Alg. Schl. p. 113.

In similar or the same places as the foregoing, with which it is often associated.

Plate XI. fig. 2. *a, b, c,* family groups; *d,* free cells. All magnified 400 diam.

GENUS 19. **OOCYSTIS.** *Näg.* (1855.)

Cells oblong, chlorophyllous, either solitary or binate, quaternate, or octonate; contained at first within an ample simple mother cell, at length free by dissolution of the membrane.

This genus, as Mr. Archer has observed (Micr. Journ., 1877, p. 105), comes very near *Nephrocytium*, the seemingly only very tangible dis-

[redacted]

became more dense, and the reticulated arrangements lost, or rather, perhaps, more properly speaking, the interspaces become clothed with chlorophyll granules. At first glance this might be mistaken, under a low power, for that small form of *Eremosphæra viridis*, which originates when the individuals of the ordinary large form produce simultaneously four, in place of two daughter cells; but the evident elliptic figure and the thickened poles, as well as the different arrangement of the chlorophyll contents, would, on closer inspection, at once distinguish them. Mr. Archer has drawn attention to the seemingly curious very great expansion of the wall of the mother-cell, almost looking as if in anticipation, rather than as in consequence of the growth of a young 'brood' of two, four, eight, or sixteen daughter-cells, so much so that it almost had the aspect of a fresh growth, rather than that of a mere swelling up of the old membrane."—*Quart. Journ. Micr. Sci.*, 1877, *p.* 105.

Oocystis setigera. *Archer, in Quart. Journ. Micr. Sci.*, 1877, *p.* 194.

We are unable to give any description of this species which, as far as we are aware, bears only a manuscript name. Neither are we able to give figures of either species, although we hope to do so hereafter.

GENUS 20. DIMORPHOCOCCUS. *Br.* (1849.)

Cells united in fours on very short branches, dissimilar, the two intermediate contiguous oblique, obtuse ovate, the two lateral, opposite and separate from each other, lunate; families free swimming, in botryoid clusters.

This genus is allied to *Dictyosphærium*, next to which it should have been placed.

Dimorphococcus lunatus. *Br. Alg. Uni. p.* 44.

Green, apices of the cells hyaline.

SIZE. Cells longitudinal diam. ·01-·02 mm.

Rabh. Alg. iii. p. 36. Archer, Quart. Journ. Micr. Sci., 1872, pp. 195, 197.

Floating in pools. N. Wales.

We have been unable to make a successful drawing from the specimen we possess of this Alga, as we have not seen it living. Mr. Archer, on reporting upon its occurrence in Ireland, criticised the only figure extant (in Rabenhorst's Alg. Eur.) in the following terms: "The upper or outermost cells do not, as they are made to seem, or as the original description might lead one to infer, stand above the larger and lower (inner) cells as upon a common stipes, but the former grow off from the latter, and remain joined thereto by a short pedicle. The inner cels are broadly reniform, and two stand opposite to each other at the apex of the supporting stipes, so as to present a lunate figure, and from the lower part of the sinus made by these it is that the pedicle of each of the pair of secondary, more or less reniform, but unequally lobed, cells (one from each lower cell) starts, the smaller lobes of these latter overlapping each other, and appearing, in a crowded cluster, like one cell, only of smaller dimensions, concentrically posed above the lower

cell, and as if on a common stipes, that is, as if all were 'in ramulis —quaternatim conjunctæ.' " The larger lower cells are combined, inter se, by a soft irregular colourless furcated (almost as if shrivelled) stalk, into a crowded colony or family. This branched cluster of cells requires to be broken up and pressed out ere the arrangement referred to can be seen. The structure and mode of arrangement of the cells (which are bright green, with a pale narrow little space at the upper extremity, and with large chlorophyll granules) becomes thus of somewhat complex appearance, nor did it appear to have been made out fully by Braun himself, as conveyed by his description.—See *Quart. Journ. Micr. Science*, 1872, pp. 195, 198.

Genus 21. **MISCHOCOCCUS.** *Näg.* (1849.)

Thallus dichotomously branched, bearing the terminal cells. Cells globose, terminal, geminate or quaternate. Division of cells in one direction. Propagation by zoogonidia.

This genus is confined at present to a single species.

Mischococcus confervicola. *Näg. Einz. Alg. p.* 82.

Cells globose, even, geminate, ternate or quaternate, on the tips of the branches, bright green, delicately granular, destitute of a chlorophyllose vesicle; stem hyaline, spuriously articulated, often swollen at the angles.

Size. Cells ·0045-·009 mm. (*Rabh.*).

Rabh. Alg. iii. p. 54, fig. 29.

Attached to filamentous Algæ in ditches, near Stafford, August, 1849 (Rev. R. C. Douglas).

This interesting little plant is liable to be overlooked on account of its small size and the delicate hyaline stem, only the pair, or more, of little globose green cells being at first visible.

Plate XI. fig. 4. *a*, two plants parasitic on Conferva; *b*, young [redacted]

FAMILY II. PROTOCOCCACEÆ.

Unicellular algæ, in the strictest sense, chlorophyllous, without terminal growth, or ramification, without a vegetative generation of cells. Either single, segregate, or associated in families. Cells of the families either indefinitely increasing in number (then forming *families*) or of a definite number (then forming a *cœnobium*).

Propagation by means of gonidia, arising in the mother cell by free cell formation; gonidia of two kinds, the one larger, *macrogonidia*, the other smaller, *microgonidia;* the former oblong, mostly produced anteriorly into a pale bi-ciliate beak, rounded and greenish at the posterior end, developing into an individual plant; the microgonidia similar to these, and also motile, but passing after a short time into a quiescent state, and at last into resting spores, or hypnospores.

This family is usually subdivided into the following sub-families:—

1. PROTOCOCCEÆ.
2. CHLOROCOCCACEÆ.
3. POLYEDRIEÆ.
4. SCENEDESMEÆ.
5. HYDRODICTYEÆ.
6. OPHIOCYTIEÆ.
7. PEDIASTREÆ.
8. SORASTREÆ.
9. CHARACIEÆ.

Many of these small sub-families include but a single genus, so that, in effect, the character of the sub-family is that of the genus; hence they are of little value, especially in a local flora.

Sub-Family 1. PROTOCOCCEÆ.

Cells sphæroid, segregate; cytioderm thin, hyaline, without integument, swimming free, or, when not growing in water, forming a thin pulverulent stratum. Contents in the beginning homogenous, then granular, green, or reddish.

Only one genus has yet found a place in this sub-family, of which one species is British.

GENUS 22. **PROTOCOCCUS.** *Ag.* (1824.)

Characters the same as in the sub-family. Propagation by mobile gonidia.

Protococcus viridis. *Ag. Rabh. Alg.* III., 56.

Cells small, segregate, accumulated in a broadly expanded stratum, of a yellowish green colour, either pulverulent, or, during moist weather and after rain, somewhat gelatinous.

SIZE. Cells ·0025-·004 mm.

On the trunks of trees, fallen branches, and damp walls throughout the year.

It is very probable that this is only a condition of *Pleurococcus vulgaris.*

Plate XII. fig. 1. Cells magnified 400 diameters.

Sub-Family 2. CHLOROCOCCACEÆ.

Cells sphæroid, either single and free, furnished with a chlorophyllose vesicle and a pale lateral spot, sometimes with an ample tegument, or more often accumulated in strata or little clusters. Propagation by zoospores, formed by division of the cell contents, escaping by rupture of the cell wall.

GENUS 23. **CHLOROCOCCUM.** *Fries.* (1825.)

Cells subglobose, single or in clusters. Characters the same as the sub-family.

A. *Species green.*

† *Tegument thin.*

Chlorococcum humicolum. (*Näg.*) *Rabh. Kr. Fl. Sachs,* 137.

Stratum effused, dark-green, pulverulent; cells globose, variable in size, often many united in families, involved in a common hyaline tegument; cell membrane thin, but thickening with age; contents at first pale or yellowish-green, homogenous, at length dark-green, granular.

SIZE. Cells ·017 mm. diam., or less.

Rabh. Alg. iii. 58.

Cystococcus humicola, Näg. Einz. Alg. 85, t. 3, f. E.

On the naked ground (*A. W. Wills*).

Plate XII. fig. 5. Cells and family magnified 400 diameters.

Chlorococcum frustulosum. (*Carm.*) *Rabh. Alg.* III., 59.

Thallus effused, pulverulent, green; cells globose, of medium size, associated in families which are involved in a broad hyaline homogenous envelope.

SIZE. Cells ·007 mm. diam.; families to ·04 mm. diam.

[redacted]

We have retained this in its present position in deference to Rabenhorst, to whom the species must have been known. At the same time its æruginous green colour seems to indicate an affinity with *Phycochromophyceæ* rather than the present order.

"Plant producing spots on walls and stones of a yellowish green colour, and at first very small, but afterwards indefinitely larger, from a number becoming confluent. First discovered in this country by the Rev. M. J. Berkeley on the freestone walls of Christ College, Cambridge."—*Greville.*

Plate XII. fig. 4. Cells magnified 400 diameters. Some undergoing division.

†† *Tegument thick.*

Chlorococcum gigas. *Grun. in Rabh. Alg., No.* 1436.

Stratum thin, green, mucous; cells globose, large, either single or associated in small families, always involved in a broad, distinctly lamellose hyaline tegument.

Size. Cells ·012-·017 mm. diam. without the hyaline membrane.

Protococcus gigas, Kutz. Phy. Gen. p. 145.

In pools, on walls and glass windows.

One of the finest species in this genus, and possibly not uncommon. We have met with it two or three times, but not in any great quantity. It must not be confounded with *Glœocystis ampla.*

Plate XII. fig. 3. Cells magnified 400 diameters. *b*, in different stages of division.

B. *Species red, rusty, or orange.*

No British species in this section recorded.

Sub-Family 3. Polyedrieæ.

Cells single, segregate, free swimming, compressed, 3-4-8 angled; angles more or less produced, sometimes radially elongated, either entire or bifid, mostly armed, oblong-elliptic when viewed laterally, rounded or rather truncate at the ends. Cell-membrane thin, even. Chlorophyll-mass mostly granular, equally distributed through the cell, sometimes with 1-4 reddish oil-drops. Propagation unknown.

Genus 24. **POLYEDRIUM.** *Näg.* (1849.)

Characters the same as above for the sub-family.

A. *Angles entire.*

Polyedrium gigas. *Wittr. Sotvattensalger, p.* 33, *t.* 4, *f.* 4.

Cells irregularly pentahedrical (rarely hexahedrical), angles obtuse, sides concave.

Size. Maximum diameter of cells ·065-·075 mm.; minimum diameter ·035-·045 mm.

Archer, in Quart. Journ. Micr. Science xvii. (1877), p 105.

In standing pools.

This large and distinct species has the angles rounded and unarmed.

Plate XIII. fig. 1. *a, b, c*, cells in three positions, magnified 400, after Wittrock.

Polyedrium tetraedricum. *Näg. Einz. Alg.*

Cells regularly tetrahedrical; angles obtuse, mucronate.

SIZE. Cells ·015–·03 mm. diam.

Rabh. Alg. iii. 62. Archer, Micr. Journ., 1866, p. 62.

In pools.

This might possibly be mistaken for the end view of some species of *Staurastrum*, against which error it is essential that beginners should be cautioned.

Plate XIII. fig. 3. Cells magnified 400 diameters.

B. *Angles radiato-elongated.*

Polyedrium longispinum. (*Perty.*) *Rabh. Alg.* III., 62.

Quadri-radiate, radii thin, elongated, scarcely thickened into a body in the centre.

SIZE. Length of arms ·03–·05 mm.

Phycastrum longispinum, Perty Kl. Lebensf. t. xvi., f. 30.

In pools. N. Wales (*A. W. Wills*).

A peculiar species, which at first sight seems to have but little relationship with the other species figured. It is often found associated with Desmids, and delights in similar localities.

Plate XIII. fig. 2. *a, b, c, d,* cells magnified 400 diameters.

C. *Angles lobed.*

Polyedrium enorme. (*Ralfs.*) *Rabh. Alg.* III., 63.

Cells irregularly tetrahedrical, with the angles produced, hyaline, deeply bilobate; sometimes repeatedly bilobed, with the lobes mucronate.

SIZE. Cells ·025–·04 mm. diam.

Staurastrum enorme, Ralfs, t. 33, f. 11.

In pools.

"Frond very irregular and variable in form. Sometimes the front [redacted]

a cœnobium. Propagation by division in the cells whence arise gonidia, which unite themselves into a cœnobium within the mother-cell, and are at length set free by the rupture of the cell-membrane.

GENUS 25. **SCENEDESMUS.** *Meyen.* (1829.)

Cells polymorphous, equal or unequal at the ends, often produced into a spine-like horn. Frond or family composed of from 2 to 8 oblong, fusiform, or elliptic cells, connected into a single or double continuous row; propagating by means of the repeated segmentation, in parallel planes, in one or two directions, of each of the cell-contents into one or more brood families (not motile), set free by the bursting of the parent-cell wall.—*Nägeli.*

A. *Cells unarmed.*

Scenedesmus obtusus. *Meyen. Rabh. Alg.* III., 63.

Cells oblong or ovate, obtuse at the poles, 4-6-8 loosely connected in a simple series, or joined obliquely, 3-5 times as long as broad.

SIZE. Cells ·0055-·007 mm. diam.

Ralfs Ann. Nat. Hist. xv., p. 404, t. 12, f. 8. Brit. Desm. p. 193, t. 31, f. 16. Archer in Pritch. Infus. p. 753, t. 1, f. 37-39. Hass. Alg. p. 394, t. 92, f. 15.

In boggy pools.

This species appears to be much less common than *S. quadricauda*, from all forms of which it may be readily distinguished, not only by the difference in the form of the cells and absence of spines, but the remoteness of one cell from its neighbour and their alternation.

Plate XIII. fig. 5. Cells in families of 4 and 8, magnified 400 diameters.

Scenedesmus acutus. *Meyen. Rabh. Alg.* III., 63.

Cells fusiform or ovate-fusiform, acute at each extremity, 2-4-6-8 united in a series, either single and straight, or double and irregularly alternate; 3-6 times as long as broad.

SIZE. Cells ·0035-·0055 mm. diam.

Ralfs Ann. Nat. Hist. xv., p. 404, t. 12, f. 6. Brit. Desm. 193, t. 31, f. 14. Hass. Alg. 393, t. 92, f. 14.

In pools and boggy places.

var. b. **obliquus.** *Rabh. Alg.* III., 63.

Cells elliptic, fusiform, arranged in two generally oblique series, the outer cell of each not in contact with any of those in the other series.

Scenedesmus obliquus, Ralfs Desm. p. 192, t. 31, f. 15. English Botany, t. 2933.

Scenedesmus triseriatus, Ralfs Ann. Nat. Hist. xv., p. 403, t. 12, f. 7.

var. c. **dimorphus.** *Rabh. Alg.* III., 63.

Cells acute, 4-8, placed evenly in a single row; inner cells fusiform, outer externally lunate.

Scenedesmus dimorphus, Ralfs. Ann. Nat. Hist xv., p. 403, t. 12, f. 5. Brit. Desm. p. 191, t. 31, f. 13. Hass. Alg. 393, t. 92, f. 13.

Formerly the typical form and its two varieties were regarded as three separate species, but there scarcely seems sufficient reason for thus retaining them. Ralfs wrote of them long ago, " When the cells are nearly uniform *S. acutus* has some resemblance to *S. dimorphus;* but in the latter the cells are more slender, never ventricose, and are arranged quite evenly side by side. It is more difficult to distinguish *S. acutus* from *S. obliquus*, and I am far from certain that Ehrenberg erred in uniting them. The principal distinction is that in *S. acutus* the cells form only a single series, which is nevertheless irregular, on account of the alternate projection of the cells in opposite directions. In *S. obliquus*, on the other hand, the cells by division form two distinct rows, which, after separation, become two fronds." These characteristics are better shown in Ralfs' figures than in our own, which are more intermediate, and show an evident approximation to the typical form.

Plate XIII. fig. 6. *a*, cells of the typical form ; *b*, cells of the variety *dimorphus; c*, of the variety *obliquus*. All magnified 400 diameters.

Scenedesmus antennatus. *Breb. Ralf. Desm. t.* 35, *f.* 27.

Cells fusiform, 2-4-8, joined in a single or double series, all somewhat curved, usually ventricose, cuspidate at each extremity, the apices bearing a hyaline globule.

SIZE. Cells ·0025-·0035 mm. diam., ·013 mm. long.

Rabh. Alg. iii. 63. Archer in Pritch. Infus. p. 753.

In pools.

" *Scenedesmus antennatus* resembles *S. acutus* in form, and also in the arrangements of the cells; but is distinguished from that and every other species by having the attenuated points tipped by minute globules."—*Ralfs.*

The commonest of British species. A variety has been described which differs only in being entirely destitute of bristles. We can confirm Ralfs in his observation that the species of this genus frequently make their appearance in clear water that is kept in glasses or bottles and exposed to the light. He says that he has repeatedly noticed the appearance of *S. acutus* var. *obliquus* in bottles containing *Desmidieæ*, and sometimes its rapid increase so as to outnumber its companions. Specimens obtained in this manner, he adds, are frequently more or less distorted. In little aquaria the present species often becomes a nuisance from its profusion.

Plate XIII. fig. 8. Cells magnified 400 diameters.

Sub-Family 5. HYDRODICTYEÆ.

Individual cells oblong-cylindrical, united into a reticulated saccate cœnobium, all fertile, some producing macrogonidia, which join themselves into a cœnobium within the mother-cell, others producing microgonidia, which are furnished with two vibratile cilia and a lateral red spot; these escape from the parent-cell, and, after a brief motile period, subside into protococcoid, thick-walled spores.

GENUS 26. **HYDRODICTYON.** *Roth.* (1800.)

Characters the same as in the sub-family.

"The genus *Hydrodictyon* comprises, as far as known, but a single species, which is common to North America and Europe. It grows in great abundance in the neighbourhood of Philadelphia, especially in the ditches and stagnant brick ponds in the low grounds below the city, known as the 'Neck.' There it very frequently forms floating masses several inches in thickness, and many feet in extent, so that with the aid of a rake it could be gathered by the bushel. When thus in mass the colour is very generally dingy and yellowish, although the fronds, when in active vegetative life, are mostly of a bright, beautiful green. The plant is in greatest profusion in June and July, after which time it gradually disappears, until in the autumn it is scarcely to be found, but early in the spring it reappears. The very young fronds are minute, oval, cylindrical, filmy-looking closed nets, with the meshes not appreciable to the eye; when growth takes place the fronds enlarge, until finally they form beautiful cylindrical nets, two to six inches in length, with their meshes very distinct, and their ends closed. In the bright sunlight, they, of course, by virtue of the life functions of their chlorophyl, liberate oxygen, which, being free to the interior of the net, and its exit barred by the fine meshes, collects as a bubble in one end of the cylinder, and buoys it up, so that, the heavier ends sinking, the net is suspended, as it were, vertically in the water. I know of few things of the kind more beautiful than a jar of limpid water with masses of these little nets hanging from the surface like curtains of sheen in the bright sunlight. A few cells collected in the fall or early spring, if put into a preserving jar, and the water occasionally changed, will multiply, and in a little while become a source of frequent pleasure to the watcher.

"As the fronds increase in size they are always in some way or other broken up, so that, instead of being closed cylinders, they appear as simple open networks of less or greater extent. The extreme length to which the frond attains is, I think, very rarely over twelve inches, with meshes of about a third of an inch in length. The construction of the frond is always the same. It is composed of cylindrical cells united end

to end in such a way as to form polygonal and mostly pentagonal meshes, the size of which varies with the age of the plant. These cells, which are closely conjoined, but have no passage-ways between them, are capable of independent life, so that the *Hydrodictyon* may be looked upon as an elaborate type of a cell-family, one in which cells are conjoined in accordance with a definite plan, so as to make a body of definite shape and size, yet in which each cell is an independent being, drawing nothing from its neighbours. The cells themselves are cylindrical, with a thickish cellulose wall, and having no nuclei. Their chlorophyllous protoplasm is granular, and is placed in the exterior portion of the cell, forming thus, within the outer wall, a hollow cylinder, in which are imbedded starch granules, and whose interior is occupied with watery contents. The *Hydrodictyon* cell, when once formed, is capable of growth, but not of going through the usual process of cell multiplication by division, so that the adult frond is composed of just as many and, indeed, the same cells as it had in its earliest infancy.

"No true sexual reproduction has as yet been discovered in the water-nets. There have been described, however, two forms or methods in which the species multiplies, both of them occurring by means of motile zoosporoid bodies. In the one case these develop immediately into the new plant, whilst in the other, before doing so, they pass through a resting stage. Of the life history of the latter, the *microgonidia*, I have no personal knowledge.

"The investigation of the production and development of the *macrogonidia*, however, has occupied considerable of the time devoted by myself to the microscope, and I have seen large numbers of specimens in almost all the stages of development. I have never been able to detect any decided motion in the *macrogonidia*.

"They are formed in the protoplasmic stratum already alluded to as occupying the outer portion of the interior of the *Hydrodictyon* cell. The first alteration in this, presaging their formation, is a disappearance of the starch granules, and a loss of the beautiful transparent green colour. Shortly after this, even before all traces of the starch-grain are gone, there appear in the protoplasm numerous bright spots placed at regular intervals; these are the centres of development, around which the new bodies are to form. As the process goes on, the chlorophyl granules draw more and more closely around these points, and at the same time the mass becomes more and more opaque, dull, and yellowish

adult *Hydrodictyon*. The primary cell wall now becomes more and more gelatinous, and soon undergoes complete solution, so that the new frond is set free in its native element.

"It is evident that when the species is multiplied in the way just described the birth of the new frond is consentaneous with the death of the old cell. But when the *Hydrodictyon* disappear in the fall, it is months before they reappear in the spring. It is, therefore, evident there must be some other method of reproduction. This slow development of new fronds takes place, according to Pringsheim, by means of little motile bodies which he calls *Dauerschwarmer*, which has been translated in English *Chronispores* (*statospores*, Hicks). M. Braun stated already some years since that sometimes, instead of the *Hydrodictyon* producing the ordinary reproductive bodies (*macrogonidia*), there are formed in the cells much smaller and more active bodies, the *microgonidia*. The changes which occur in the production of these are very similar to those already described as happening when the macrogonidia are formed. When the *chronispores* are formed, however, they, instead of uniting together, escape in a free, distinct condition with the water. They are now small ovate bodies, with a large anterior transparent space, to which are attached a pair of cilia, and their life and history, according to Pringsheim, is as follows:—For a few hours they move about very actively in the water, and then, dropping their cilia, and acquiring an outer cellulose wall, pass into a quiescent stage, in which they closely resemble *Protococcus* granules. They are capable of living in this state for a long time if kept in water. They can also endure dessication if the light be excluded during the process, but if it be present, they wither and die, and cannot be revivified.

"After a longer or shorter period, but never shorter than three months, according to Pringsheim, they recommence their life, provided they be in water. For four or five months after this the chief change consists simply in an increase in size. The dark green protoplasm is arranged around the exterior of the cell; within are the more fluid colourless contents, the whole body still looking like a *Protococcus* cell. After a size of about $\frac{1}{40}$th mm. is attained, the endochrome divides successively into several portions. The external layers of the surrounding wall now give way in some spot, and allow the inner layers to protrude and form a sort of hernial sac, into which the several endochrome masses soon pass, at the same time assuming the well-known characters of true zoospores. From two to five of these bodies are thus produced out of each original microgonidium. They are large, ovate, biciliate, and, generally, soon escaping from the hernial sac, move about actively in the water for a few minutes. Sometimes, however, they settle down within the generative utricle. In either case, after a little time, they become motionless, lose their cilia, and develop into polyhedral cells, which are structurally remarkable for having their angles prolonged into long, horn-like appendages. Under favourable circumstances, at the end of a few days, the bright green endochrome of these undergoes similar changes to those described as presaging the production of the microgonidia, and is finally formed into zoospores, which, in from twenty to forty minutes, unite, within the polyhedron or large cells, into *Hydrodictyon*, which is finally set free by a solution of the cellulose coat of the polyhedron. The network thus formed differs in no essential way from that which arises in the better known way, except that it is composed of much fewer cells. It is generally a closed sac; but when the polyhedron, out of which it is developed, is small, it is sometimes merely an open network. Its after-history appears to be identical with that of the ordinary *Hydrodictyon* frond."—*Dr. H. C. Wood*, "*American F. Water Algæ.*"

Hydrodictyon utriculatum. *Roth. Rabh. Alg.* 66.

Size of the families (net) variable; also of the cells (forming the meshes) and the gonidia, according to circumstances.

Eng. Flora v., p. 359. Harv. Man p. 140. Eng. Bot. (Ed. 2) t. 2504. Hook. Scot ii. 80. Gray. Arrang. i., p. 300. Hass. Alg. 225, t. 58.

Conferva reticulata, Dillw. Conf. t. 97. Eng. Bot. (Ed. 1) t. 1687. Huds. Ang. ii. 596. Relhan Cant. 444. Hull Br. Fl. 331. Abbot Bedf. 275. With. iv. 132. Ray Syn. p. 59. Dillen. Musc. 20, t. 4, f. 14.

In clear water.

For the development of this species see remarks under the genus, and also an elaborate account in Braun on Rejuvenescence, pp. 137, 171, 190, 197, 222, and 261. Observations by Cohn "Der Mikroskopischen Algen und Pilze," p. 109, and Pringsheim "Dauerschwärmer des Wassernetzes" (Berlin, 1861).

Plate XIV. fig. 1. *a*, "Water net," natural size; *b*, one of the "meshes" magnified; *c*, cell with microgonidia × 300, after Cohn; *d*, portion of cell with angular macrogonidia × 300, after Cohn; *e*, free macrogonidia; *f*, active macrogonidia × 600.

Sub-Family 6. OPHIOCYTIEÆ.

Cells cylindrical, unæquipolar, at first short, then elongated, either variously curved and contorted, sometimes circinate, one or other pole attenuated into a thin, short stem, free swimming; either straight or more or less curved, collected in an umbel with a simple stem, or being repeated, forming a composite umbel. Cell-contents parietal, homogenous or granular, green, sometimes mixed with scattered reddish or brownish globules. Propagation by gonidia.—*Rabh. Alg. Eur.* iii. 66.

Ophiocytium, "Science Gossip," June, 1867, p. 127, fig. 103.

In pools, mixed with other algæ.

Plate XIV. fig. 2. *a*, young cells; *c*, older cells; *b*, mature cell × 400.

GENUS 28. **SCIADIUM.** *Braun.* (1855.)

Plant from a single individual producing a family. Thallus (solitary) adnate, unicellular; cell elongated, cylindrical, straight, attenuated at the base into a slender stem. Gonidia about 8, resulting from division of the cell-contents, at length protruding from the ruptured apex, retained at the mouth and extending in the form of an umbel, each individual becoming developed into a cylindrical cell like the mother-cell. This process is repeated to a third, or sometimes a fourth generation, forming a composite or decomposite umbel. Ultimate cells producing free biciliate zoogonidia.

The cylindrical cell of *Sciadium* possesses uniformly distributed green contents, which are interrupted, in perfectly developed cells, by light cross streaks, and are divided into a row of 5 to 8 about equal masses, which become gonidia. I could not detect nuclei in the individual segments of the contents passing into the formation of gonidia.—*Braun Rejuvenescence*, p. 260.

Sciadium arbuscula. *Braun Unicell. Alg. p.* 106, *t.* 4.

Umbellate. Cells straight (rarely falcate), obtuse at the apex; stem about as long as the diameter of the cells.

SIZE. Cells ·0038 mm. (rarely ·007 mm.) diam.

Sciadium arbuscula, Micr. Journ., 1866, p. 4. Archer, Micr. Journ. xii., 1872, p. 314.

Ophiocytium arbuscula (Br.), Rabh. Alg. Eur. iii. 68.

Attached to confervoid algæ and aquatic plants.

Braun, writing of this species, says—"It displays an originally obovate tube, generally becoming elongated into a cylindrical form, obtuse above, and prolonged into a slender attached pedicel below. The contents consist of uniformly green mucilage, in which a small vesicle may sometimes be distinguished, but only in the earliest stage of growth. The pedicel is transparent and colourless, and secretes at its base an originally yellowish brown, afterwards dark brown mass, which gradually expands into a disc-shaped foot. When the growth is completed the green contents become divided into several masses, developing into a series of 5-8 germ cells; the cell membrane dehisces, throwing off its summit as a finger-stall-shaped cover, but the germ cells, instead of leaving the open tube, all collect at the point of exit with their inferior, narrower, and somewhat pedicellately elongated ends sticking in the tube. Thus is produced a capitule, and by the advancing growth of the young family an umbel formed of individuals exactly resembling the parent individual from which they originated. The emptied mother-cell tube remains as the stem and support of the umbellate family, and gradually becomes filled from above downwards with the same yellow and reddish brown secreted substance which it exhibits at its own base. The

imperfect birth of the germ cells just described is repeated at the transition to the third, and mostly even to the fourth generation, so that little arborescent groups are produced with twice or thrice-repeated umbellate ramification, till at length the cells which form the outermost umbellules scatter out their germ cells, which, after a short swarming, fix themselves again to be developed into ramified stocks of new families"—*Braun Rejuvenescence*, p. 187.

Plate XV. *a*, *b*, young cells; *c*, commencement of the first generation of daughter-cells; *d*, further progress of the first generation of progeny; *e*, second generation being evolved from the first; *f*, old plant evolving a third generation × 300, after Braun; *g*, zoogonidia.

Sub-Family 7. PEDIASTREÆ.

Cœnobium discoid, plane.

For other features of this sub-family see the characters of the genus, which is the only one at present comprised within it.

GENUS 29. **Pediastrum.** *Meyen.* (1829.)

Cœnobium plane, frond-like, discoid, or stellate, free swimming, formed of cells in a single, rarely in the centre in a double stratum, continuous, or with the cells here and there interrupted, perforate or clathrate. Cells polygonal, central entire or slightly emarginate, those of the periphery entire or two-lobed, the lobes wedge-shaped, either simple or two-toothed, sometimes elongated into a horn. Cell-contents green, homogeneous at first, then granular.—*Rabh. Alg. Eur.* iii. 69.

Formerly this genus was included in Desmidiaceæ, but the knowledge of its life history has shown that it has no relationship with the Conjugatæ. Braun illustrated the development of one species (Rejuvenescence, Pl. III.), and we have reproduced some of his figures (on Pl. XVI.) Fig. 1 is an old disc, in great part emptied by the birth of gonidia. [redacted]

not even yet closely connected together, but exhibit spaces between them, so that in this stage it resembles *P. pertusum.* Not until the second day do the cells become closely applied together; the horns acquire their proper shape and length at the same time. All the figures are magnified 400 diameters.

The number of cells which enter into the composition of a single disc vary in the same species, so that it cannot be accepted as a character. The arrangement and limit of species adopted are those proposed by Braun ("*Algarum unicellarum*," 1855).

Plate XVI. figs. 1 to 7. Development of *Pediastrum*, after Braun; 8 *a*, *b*, zoogonidia.

SECTION 3. *DIACTINIUM.* *Braun.*

Cells of periphery emarginate or bilobate, lobes entire.

Pediastrum selenæa. *Kutz.* *Rabh. Alg.* III. 73.

Cœnobium orbicular, entire, formed of 8-16 (rarely 31) cells. Cells of periphery narrow, lunate, acutely lobed; cells of disc slightly excised, central one five-angled; substance firm, rather thick.

SIZE.* Cœnobium ·028-·085 mm. diam.

Braun Unicell. Alg. p. 83. Ralfs Desm. t. 21, f. 5.

Pediastrum Napoleonis, Ralfs Ann. N. Hist. xiv. (1844) t. 12, f. 6.

Pediastrum elegans, Hassall Alg. t. 86, f. 19.

Pediastrum lunare, Hassall Alg. t. 92, f. 3.

In bogs, moor pools, &c.

Plate XVI. fig. 9. *a*, 8-celled cœnobium; *b*, 16-celled cœnobium × 400 diameters; *c*, marginal cell.

Pediastrum angulosum. *Ehr.* *Rabh. Alg.* III. 73.

Cœnobium orbicular, oblong, or subreniform, continuous, composed of 8-16-32-64 cells. Cells all even, angular, those of the periphery truncate at the base and dilated upwards, more or less deeply notched in the middle, the lobes obliquely truncate, outer angle very shortly apiculate, inner one ending in a short horn. Central cells 5-6 angled, slightly repand in front, marked with a small transverse oblong pallid spot.

SIZE. Cœnobium ·12 mm. diam.; cells ·019 diam.

Hass. Alg. t. 86, f. 14. Ralfs Desm. t. 31, f. 11 *a b*. Braun Unic. Alg. p. 84.

Pediastrum Boryanum, Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 7, upper.

Pediastrum excavatum, Hassall Alg. t. 92, f. 6.

In bogs.

Plate XVI. fig. 10. *a*, marginal cells; *b*, 16-celled cœnobium; *c*, 8-celled cœnobium × 400 diameters.

* The size must depend on the number of cells of which the cœnobium is composed; hence throughout this genus the dimensions given must only be accepted as approximate.

Pediastrum Boryanum. *Turp. Rabh. Alg.* III. 74.

Cœnobium orbicular, oblong, or elliptic, variable in size, continuous, bright green, composed of 4-8-16-32-64 (rarely 128) cells. Cells of periphery more or less deeply emarginate, or two-lobed, lobes horn-like, horns colourless, short or long, straight, obtuse or nearly so, sometimes a little thickened; central cells very closely concrete, 4-6 angled, angular or truncate in front, or slightly repand; membrane decussately punctate.

Size. Cells ·02-·002 mm. transverse diam.

Braun Unic. Alg. p. 86. Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 7, lower. Ralfs Desm. t. 31, f. 9 *a*. Hassall Alg. t. 86, f. 13.

Pediastrum hexactis, Hassall Alg. t. 92, f. 5.

Pediastrum Napoleonis, Ralfs Desm. t. 31, f. 7 *a* and *d* (short-horned form); f. *b* (long-horned form).

Pediastrum simplex B. cruciatum, Ralfs Desm. t. 34, f. 15 *d*.

Pediastrum granulatum, Braun "Rejuvenescence," pl. 3, 4 (English edition). Pritch. Infus. t. 1, f. 59-69.

In boggy pools.

Plate XVI. fig. 11. *a*, 4-celled cœnobium; *b* and *e*, 16-celled cœnobium; *c*, 32-celled cœnobium; *d*, 8-celled cœnobium × 400 diameters.

var. B. **granulatum.** *Kutz.*

Cells as in the preceding, but all the cells and the horns distinctly granulated.

Braun Unicel. Alg. p. 90.

Pediastrum granulatum, Ralfs Desm. t. 31, f. 8.

In the same localities.

Plate XVI. fig. 12. *a*, *b*, 8-celled cœnobia × 400 diameters.

[redacted]

periphery irregularly two-lobed, sinus narrow, lobes unequal, now and then constricted at the base, produced into an obtuse, rather thick horn; central cells polygonal, repand in front.

Rabh. Alg. iii. 77.

Pediastrum ellipticum, Ralfs Desm. t. 31, f. 10 *d*.

Pediastrum Boryanum, *β*., Ralfs Ann. Nat. Hist. xiv. (1844) f. 8.

In standing water.

Braun suspects the verity of this species, which we have never seen.

Plate XVII. fig. 2. *a*, 32-celled cœnobium; *b*, 16-celled cœnobium × 400 diameters, after Ralfs; *c*, marginal cells.

Pediastrum gracile. *Br. Unic. Alg.* p. 93.

Cells quaternate, closely joined in a circle, centre open, rarely closed; cells deeply two-lobed, lobes ovate, produced into a long divergent, acuminate horn.

Rabh. Alg. iii. 75.

Pediastrum simplex, Ralfs Desm. t. 34, f. 15 *a b*.

In pools.

This appears to be a very rare species, at first referred to *P. simplex* Meyen, from which it differs in the cells, being deeply two-lobed.

Plate XVII. fig. 3. 4-celled cœnobia × 400 diameters, after Ralfs.

Pediastrum pertusum. *Kutz. Phy. Germ.* p. 143.

Cœnobium orbicular, pierced with lacunæ, of variable size, composed of as many as 64 cells; cells of the periphery loosely connected at the base, bilobed almost to the middle; lobes straight, produced into a hyaline horn, sometimes acute, sometimes obtuse or truncate; central cells more or less exactly quadrangular, emarginate in front, even. with two paler spots.

SIZE. Perfect cells ·016-·022 mm. transverse diam.

Rabh. Alg. iii. 75. Ralfs Desm. t. 31, f. 6 *a*, *b*. Braun Unicell. Alg. p. 92.

Pediastrum Napoleonis, Ralfs Desm. t. 31, f. 7 *c* and *e*.

Pediastrum selenæa, Kutz., Pritch. Inf. t. 1, f. 53.

In pools.

Plate XVII. fig. 4. *a*, *b*, *c*, 8-celled cœnobia; *d*, 32-celled cœnobium; *e*, 16-celled cœnobium.

var. *b*. **clathratum.** *Br. Unicell. Alg. p.* 93.

Disc pierced with larger openings; central cells deeply notched and bilobate.

Pediastrum cribriforme, Hassall Alg. t. 92, f. 4.

Plate XVII. fig. 5. 16-celled cœnobium.

var. *c*. **brachylobum.** *Braun Unicell. Alg. p.* 93.

Cells larger, those of the periphery emarginate or triangularly notched, shortly two-lobed; horns very short, truncate,

or almost obsolete; cells of the disc perforated with smaller openings.

Pediastrum tricyclum, Hassall Alg. t. 92, f. 1.

Pediastrum Napoleonis, Hassall Alg. t. 92, f. 10. (?)

Plate XVII. fig. 6. *a*, 5-celled cœnobium; *b*, 16-celled cœnobium, fig. 4; *f*, marginal cell.

Section 4. *TETRACTINIUM*. *Braun*.

Cells of periphery emarginate or bilobate; lobes emarginate, bidentate, or bifid.

Pediastrum Ehrenbergii, *Br. Rabh. Alg.* III., 72.

Cœnobium orbicular or oblong, perfectly closed, composed of 8-16 cells, or quadrate, of 4 cells, which are wedge-shaped, deeply lobed and arranged in the form of a cross; cells of the periphery cuneate, truncate at the base, deeply bilobate; sinus narrow, lobes obliquely truncate, more or less notched, interior angles twice as long, all acute, or shortly appendiculate; central cells yellow green, polygonal, one side repand or deeply notched.

Pritch. Infus. t. 1, f. 52.

Pediastrum tetras, Ralfs Desm. t. 31, f. 1. Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 4. Hassall Alg. t. 86, f. 17.

Pediastrum heptactis, Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 5. Ralfs Desm. t. 31, f. 2.

Pediastrum simplex, Hassall Alg. t. 8, f. 17.

Pediastrum biradiatum, Ralfs Desm. t. 31, f. 3, 4.

In pools and boggy places. Not uncommon.

Very variable in size. The 4-celled cœnobia are often to be met with, mixed with Desmids and other Algæ.

Pediastrum rotula. (*Ehr.*) *Br. Unicell. Alg. p.* 101.

Cœnobium orbicular or oblong, size and number of cells variable, 4-8-16-32, pierced with openings, bright green, even; cells of the periphery truncate at the base, more or less dilated upwards, deeply bifid, sinus acute, lobes straight, narrow, bidentate, teeth erect or divergent, somewhat bent; cells of the centre variable in form, usually polygonal, repand, or notched, containing a single paler spot, sometimes not visible.

Rabh. Alg. iii. p. 79.

Pediastrum heptactis, Hassall Alg. t. 92, f. 9.

Pediastrum incisum, Hassall Alg. t. 92, f. 8.

In pools, &c., throughout Europe.

Plate XVIII. fig. 2. *b*, marginal cell; *a*, 4-celled cœnobium; *c*, 6-celled cœnobium; *d*, 8-celled cœnobium; *e, f, h*, 16-celled cœnobium; *g*, irregular cœnobium.

Sub-Family 8. SORASTREÆ.

Cells polygonal, often shortly horned, associated in a hollow, sphærical or cubical cœnobium; cell-membrane thin; cell-contents green, homogeneous, then granular; chlorophyllose vesicle central or sublateral. Propagation by gonidia, in two modes in the same species (simultaneous, or after division), united into a cœnobium within the mother-cell, escaping by rupture of the membrane.—*Rabh. Alg. Eur.* iii. 79.

GENUS 30. **CŒLASTRUM.** *Näg.* (1849.)

Cœnobium globose, hollow within, formed of a single stratum of cells, reticulately pierced.—*Rabh. Alg. Eur.* iii. 79.

Frond, or family, hollow, globular, or subcubical, composed of polygonal or sphærical cells, united in one layer into a hollow clathrate netlike family, the cells drawn out on the exterior into one or more lobes, or simply sphærical; propagating by the segmentation of the cell-contents into a definite number of portions which become arranged into a hollow young frond, resembling the parent, ultimately set free by the bursting of the parent cell.—*Pritch.* 755.

Cœlastrum sphæricum. *Näg. Ein. Alg.* 97.

Cœnobium globose or subglobose, composed of 4-8-16 or a larger number of cells, perforated, areolæ 3-4-5-6 angled; cells rounded, by mutual pressure angular, outer angles somewhat conical, obtusely rounded at the apex; interstices 5-6 angled.

SIZE. Cœnobium ·04-·085 mm. diam.; cells ·021-·023 mm.

Cœlastrum Naegelii, Rabh. Alg. iii. 79. Archer in Pritch. Infus. p. 755, t. 1, f. 49-55.

In boggy places.

Plate XIX. fig. 2. *a, b*, families magnified 400 diameters; *c*, cell magnified 800; *d*, cell of *C. cubicum*, with two obtuse processes; *e*, cell of *Cœlastrum*, perhaps *C. cambricum*, with one obtuse process.

Cœlastrum cambricum. *Archer Micro. Journ.*, 1868, *p.* 65.

Cells rounded on the exterior margin, each bearing a single truncate tubercular process.

In pools.

"It was obtained by Mr. Archer on his visit to Wales, and is not referable to either of the remaining forms (besides *C. sphæricum*) as described by Nägeli, though perhaps showing most affinity with *Cœlastrum cubicum*, but differing in each cell possessing but one process, or tubercle-like appendage, not three. These likewise showed various conditions of the growth of the young cœnobia within the mother-cells from the earliest stage, the most minute of which showed the full character of the cells, each with the truncate tubercle-like process."—*Quart. Journ. Micro. Soc.*, l.c.

Cœlastrum microsporum. *(Näg.) Braun Alg. Unic. p.* 70.

Cells 8-16 or 32, exactly sphærical, containing a single globule; interstices small.

SIZE. Cœnobium ·04 mm. diam.; cells ·009 mm. diam.

Micr. Journ., 1868, p. 65. Pritchard's Infus. f. 755.

In bogs and pools.

"The group (cœnobium) is formed of rather large cells, externally globularly rounded, their margins, where in mutual contact, being straight, and leaving at the angles exceedingly minute, somewhat triangular interspaces, like very minute pores, leading into the central cavity characteristic of the forms appertaining to this genus."—*Archer.*

GENUS 31. **STAUROGENIA.** *Kutz.*

Cœnobium cubical, hollow within, formed of 4-8-16 quadrate or sub-quadrate cells. Propagation by quiescent gonidia, produced after the subdivision of the cell-contents.—*Rab. Alg. Eur.* iii. 80.

[redacted]

The family (or cœnobium) in this genus is solid, and not hollow as in *Cœlastrum*, composed of wedge-shaped or heart-shaped cells, somewhat compressed and united into globose families, the narrow ends meeting in the centre, with the outer margin emarginate or divided.

Sorastrum spinulosum. *Näg. Einz. Alg. p.* 99.

Cœnobium spinulose, cells wedge-shaped, apex slightly emarginate, angles obtusely rounded, bi-spinulose.

SIZE. Cœnobium to ·04 mm. diam.

Archer Micr. Journ., 1866, p. 124. Pritch. Infus. t. 1, f. 56-58. Rabh. Alg. iii. 81. Reinsch Algenflor. p. 86, t. 5, f. 6.

In stagnant water.

Plate XIX. fig. 1. *a, b,* families magnified 400 diameters; *c,* side view of cell; *d,* front view of same.

GENUS 33. **SELENASTRUM.** *Reinsch.*

Cells semilunate, joined together by the middle of the convex margin, in families of 4-8, regularly disposed. Propagation unknown.—*Reinsch Algenflor. Frank. p.* 64.

Selenastrum Bibraianum. *Reinsch Algenflora p.* 64.

Cells semilunate, with the cusps either expanded or curved inwards; minor families constituted of four cells in pairs, major families of these combined in more or less sphærical masses.

SIZE. Cells ·016-·023 mm. long × ·005-·008 mm. diam.; minor families ·023-·031 mm. diam.

In moor pools.

Plate XIX. fig. 3. *a,* families magnified 400 diameters; *b,* pair of cells magnified 1000 diameters.

Sub-Family 9. CHARACIEÆ.

Cells always innate, often distinctly stipitate, variable in form; cell-membrane delicate, growing thicker with age (then double membrane visible); cell-contents bright green, homogenous, afterwards always granular, with one starch granule, ultimately divided. Propagation by repeated binary division of the cytioplasm, resulting in more or less numerous biciliate zoogonidia.—*Rabh. Alg. Eur.* iii. 81.

GENUS 34. **CHARACIUM.** *Braun.* (1847.)

Cells oblong, ovate, pyriform, fusiform, rarely acicular or subglobose, equal or oblique, erect or inclined, attenuated at the base in a hyaline stem. Cell-contents green, homogenous or granular, zoogonidia, succeeding division of the cytioplasm, more or less numerous, occupying the whole of the cell, at length greatly agitated, escaping by a lateral (rarely terminal) rupture, oblong, with two vibratile cilia.—*Braun Unicel. Alg. p.* 29.

Characium Sieboldi. *Br. Alg. Unic.* 32 *t.* 3, *f.* A. 1-21.

Cells erect, equal, at the beginning nearly lanceolate, when older pyriform or obovate, 2-3-4 times longer than broad, apex obtuse or broadly rounded; stem short, hyaline, base attenuated, truncate, not discoid; contents bright green or yellowish-green, granular, in the beginning with a single amylaceous granule, afterwards with several.

Size. Cells ·022-·026 mm. diam.

Rabh. Alg. iii. 83.

In clear water, attached to filiform algæ. Bangor (*W. Joshua*).

"The gonidia of this species exhibit, after they have already attached themselves by their ciliated extremities, a tremulous motion lasting for almost a quarter of an hour, and evidently commencing in the delicate stalk."—*Braun p.* 230.

Plate XX. fig. 9. Cells in various stages, *in situ*, × 400; 10, cells containing mature zoogonidia; 11, free zoogonidia.

Characium ornithocephalum. *Br. Alg. Unic. p.* 42, *t.* 3 C.

Cells from the beginning unequal, incurved, distinctly stipitate, afterwards one side swollen, semilunate, apex produced into a straight or inclined beak; stem elongated, slender, base sometimes discoid; cell-contents bright green, granular, with a central or lateral starch granule.

Size. Cells ·025-·033 mm. long, without stem, half as wide, or more.

Micr. Journ., 1867, p. 85. Rabh. Alg. iii. 86.

In pools.

Plate XIX. fig. 5. *a*, young cells; *d*, cell further advanced; *b*, *c*, *f*, mature cells in different stages of division; *e*, mature cells with endochrome artificially contracted, all magnified 600 diameters.

[redacted]

Hydrianum heteromorphum. *Reinsch contrib. p.* 80.

Cells at first globose-elliptical, attenuated below into a thin hyaline stem; contents granular, then contracted in preparation for formation of the gonidia; zoogonidia elongated, escaping at the broadly opened apex.

SIZE. Cells, unopened, ·008-·0095 mm. broad; opened cells ·0066 × ·02 mm.

Reinsch Contributiones ad Algologiam (1874) p. 80, t. 11, fig. 3.

Attached to filamentous algæ.

Plate XIX. fig. 6. *a*, cells in different stages attached to a filamentous alga magnified 400 diameters; *b*, young cells; *c*, mature cells magnified 800; *d*, cell with zoogonidia escaping, and magnified 1200 diameters; *e*, zoogonidia further magnified.

GENUS 36. **CODIOLUM.** *Braun.* (1852.)

Cells at first obovate, as they grow older becoming clavate, or nearly cylindrical, densely aggregated in tufts, base attenuated into a stem; cell-contents green, delicately granular, mixed with numerous starch granules. Propagation by zoogonidia, and also by resting spores (hypnospores).—*Braun Unic. Alg. p.* 19.

Codiolum gregarium. *Br. Alg. Unic. p.* 20.

Cells elongated, subclavate, green; many times longer than the diameter, apex rounded.

SIZE. Cells ·03 mm. diam.

Rabh. Alg. iii. 90.

On maritime rocks (*E. M. Holmes*). Also in the drip of fresh water.

Some persons contend that this is only a marine plant, others that it occurs also in the neighbourhood of the coast, but either in æstuaries or entirely removed from salt water. We include it here without prejudice to either opinion.

Plate XX. fig. 1, 2, 3, young plants; 4, 5, further developed plants; 6, mature plants × 300 diameters, one containing starch granules, the other mature zoogonidia; 7, 8, zoogonidia.

Family III. VOLVOCINEÆ.

Cœnobia mobile, globose, subglobose, or quadrangular and flattened, produced from agile biciliate green cells, with a double contractile vesicle. Common tegument of the cœnobium hyaline, more or less ample.

Propagation sexual or asexual. The sexual monæcoius or diæcious, either all or some of the cells of the cœnobium exhibiting male and female characters. Male cells containing spermatozoids (*antheridia*), the female finally changed into a quiet oospore. Non-sexual propagation by means of motile gonidia (macrogonidia and microgonidia). These arise from the simultaneous and repeated division of the cell contents (*cytioplasm*). Macrogonidia definite in number (2, 4, 8, 16, &c.), the larger oblong or rounded, with the anterior extremity more or less rostellate, with two cilia exserted through the membrane of the vesicle, furnished with a parietal red spot (*eye-spot*), and often two contractile vacuoles. Microgonidia indefinite in number, much smaller, pale or dull green, or yellowish, with cilia at the apex, mostly even within the mother-cell, endued with rapid motion, and ultimately escaping by rupture of the membrane.

Pritchard's "Infusoria" (p. 144) may be consulted with advantage, although including some genera which undoubtedly belong to Infusoria. Also the various memoirs hereafter referred to under the several genera.

The passage into amæboid conditions has been observed in several genera, but this is a subject on which further investigation is needed. T. C. White has seen it in *Chlamydococcus* ("Journ. Quekett Micr.

[redacted]

Chlamydococcus pluvialis. *Br. Rejuvenescence, p.* 206.

Cells subglobose, very variable in size, brownish red, changing in some conditions to green.

SIZE. Cells ·007-·035 mm.

Rabh. Alg. Eur. .iii, 93, Cohn Nova Acta. xxii. p. 749, t. 67 A. B. Pritchard Infus. 523, t. xix. f. 20-31. T. C. White, in "Quekett Microscopical Journ.," vi. p. 43.

Hæmatococcus pluvialis. Flotow, Nova Acta xx.

Hæmatococcus Corda. Meneg. Nost. p. 20, t. 1, f. 5.

Hæmatococcus mucosus. Morren Rubefact : des Eaux, t. 6, f. 10-20.

Protococcus pluvialis. Kutz. Tab. i. f. 1. Cohn, Memoir on Protococcus.

Protococcus monospermus. Corda, in Sturm Flora ii. 25.

On rocks, stones, &c., in hollows filled with rain water.

"Normally fully developed cells of this multiform creature, sometimes like a plant, sometimes like an animal, present the appearance of globules from ·02 to ·04 mm. diam., with a thick, tough cell membrane, and granular-punctate, opaque contents, sometimes of a brown, sometimes (at other periods, or in other localities) bright red colour. In the mass of the dark contents lie hidden several other structures, which at this period are completely concealed, namely 4-6 starch globules of ·0033 or at most ·005 mm. in diameter, in which, as in those of *Hydrodictyon*, a nucleus and an envelope may be distinguished, acquiring a violet colour with iodine, the nucleus becoming rather redder. Sulphuric acid causes a considerable swelling up of the coat. There also appears to exist in the centre of the cell a large, very delicate nuclear vesicle, which, however, is so covered up by the rest of the cell contents, that it can only be very indistinctly perceived, and cannot even be clearly displayed when the contents are squeezed out. When these resting globular cells are placed in water they give birth to four gonidium-like swarming cells. Even before the commencement of the division of the contents by which the latter are formed, a change begins in the colour of the parent cell, the red colour retreating to some extent from the periphery, and a yellow (sometimes rather greenish) border forming round the deep red inner mass. The young swarmers also, for a short time after they issue out, have only a narrow yellow rim round a dark red middle. During the two or three days' period of movement and growth of these swarming cells—in which they grow to about four times the original size, changing their obtusely ovate form at the same time to a reversed pear-shaped apiculated shape—important new changes take place in the contents of the cells. The red colour becomes more and more concentrated into the middle of the cell, so that a sharply defined bright red nucleus is formed, in the interior of which a lighter space is often clearly perceptible, corresponding to the nuclear vesicle above-mentioned, around which the red colouring matter forms a covering, mostly complete, but sometimes imperfect and interrupted. The rest of the cell contents have become a brilliant green, and in them may be clearly distinguished the above-mentioned starch granules, as well as many more smaller green granules. The ciliated point of the cell, often drawn out like a beak, is colourless. This first moving generation is succeeded by a not yet accurately determined number of similar active generations populating the water for some weeks, and often giving it a bright green colour, till at length universal rest recommences, and the

cells sink to the bottom, or attach themselves to the sides. The transition from one active generation to another takes place through a transitory resting generation of extremely short duration. The full-grown swarming cells finally come to rest within their wide shirt-like envelope, and almost simultaneously divide into two cells, which, without becoming active, divide again into two cells. Thus within the mother envelope are produced four daughter-cells (more properly grand-children), which begin to move soon after they are completely formed, and, tearing open the delicate enveloping vesicle, part company. The whole of this process of development is gone through very rapidly, being completed in one night and the succeeding morning. The second active generation, thus formed, resembles the first, with the single distinction that the active cells are green from the first, and have a smaller red nucleus in the interior. The subsequent active generations bear a general resemblance to the preceding, but many modifications present themselves. Thus, for example, we not unfrequently see the full-grown swarm-cells assume strange two-lobed, or even four-lobed, shapes, beginning to divide before they come to rest; or sometimes a transverse constriction and bisection of the cell takes place, caused by a partial protrusion of it from the loose shirt, &c. The formation of vacuoles is a pretty constant phenomenon in the later active generations, and there may be several of them eccentrically placed, with the red nucleus retaining its central position, or a single central vacuole, causing a lateral displacement of the red nucleus. This red nucleus often becomes very small in the last generations, so that it very much resembles, especially when rendered parietal by the formation of a central vacuole, the red corpuscle occurring in the gonidia of many genera of Algæ belonging to very diverse families, and which was called the 'eye' in the *Volvocineæ* by Ehrenberg.

"A total disappearance of the red colour not unfrequently occurs. In the later stages of the cycle of generations arrives, finally, the formation of microgonidia; many individuals, instead of producing four daughter-cells, undergo further division, so as to give birth to a brood of 16 or 32 minute cells, which, before they separate, form a mulberry-like body, but separating at length, commence a very active swarming inside the parent envelope, terminating in the rupture of this coat and the rapid dispersion of the little 'swarmers.' These are of longer shape than the large 'swarmers,' only about ·0066, rarely ·01 mm. long,

[redacted]

the contents their red colour, no further visible alteration takes place so long as they are kept in water. A dessication must take place before a new cycle of generations can begin. Perfectly dry specimens placed again in water ordinarily produce active gonidia the next morning. Original specimens obtained in 1841 had retained their vital force during a preservation of seven years in a herbarium.

"In order to complete the main features of the picture of the alternating generations of this multiform creature, I must notice that, in addition to the described active generations (macrogonidia and microgonidia) and the concluding generation, passing into the spore-like condition of rest, there are other generations which, as compared with the gonidium-like and spore-like conditions, must be regarded as the proper representatives of the vegetative development. These are generations endowed with quiet and slow vegetative growth, which multiply by pure vegetative division, unaccompanied by any swarming movement. It depends solely upon external conditions whether the resting cells, which are here characterized as seed-cells (spores), at once give rise to the new active generations, or to a series of quietly vegetating generations of cells. The former is the case when the seed-cells are totally immersed in water, the latter when they occur on a spot which is at once damp and exposed to the air, as is the case in the native condition, especially in the milder intervals of winter, and in the damp season of approaching spring, but temporarily also at all other seasons, on the margins of the little basins inhabited by *Chlamydococcus*, as often as they are filled by showers of rain. In cultivation in the house these vegetative generations are rarely observed, while in their native stations they certainly occupy the most important place in the alternations of the various conditions of life, as may be concluded from the thickness of the crusts and membranes formed by such vegetative multiplication. The formation and multiplication of these vegetative generations also take place by the division of the cell contents, either by simple division, the first generation being transitory, or by double halving (apparently quartering). But the newly formed cells do not slip out, like the young 'swarmers,' from the mother envelope; they remain in the same place and position. The membrane of the mother-cell appears to become softened, expands, and becomes gradually drawn out to nothing, rather than regularly burst open; it at length vanishes in some undistinguishable way, the daughter-cells meanwhile acquiring a tolerably thick, closely applied cell membrane of their own. The division is repeated many times in this way, and as the cells all remain in intimate contact, first small families, but by degrees large conglomerates of cells are produced. The size of the single cells in these groups varies from ·01 to ·02 mm.; their shape is not truly globular, but partly bounded by flat surfaces, as results from the alternating divisions, according to the three directions of space. Ordinarily the colour is light brown. If ignorant of the rest of its history, one would be led by the form and mode of division of the cells to regard these crusts as belonging to a *Pleurococcus*. In the same crusts occur isolated large cells, loosened from their connection with the others, perfectly globular in form, and appearing to divide no more, but to have passed again into the condition of resting spore cells. They are distinguished from the rest by their darker contents and thicker cell membrane. Probably the return of these to renewed resting vegetation takes place by a passage through the series of active generations. Every shower of rain will wash away these loose ripe cells of the crusts of *Chlamydococcus;* carried into collections of rain water, they will soon produce the active brood, which, returning to rest after a few active generations, settles on the margins of the little puddles, and then recurs to the resting mode of vegetative multiplication."

The foregoing life-history is somewhat abridged from the account given by Braun (" Rejuvenescence," pp. 206-214), and for further details the reader is referred to the Memoir by Flotow (" Nova Acta Naturæ Curiosorum," Vol. xx. p. 11), and that by Cohn (translated in " Memoirs " by the Ray Society, 1853), which will furnish all that can be required, and are really exhaustive. For remarks on an Amœboid condition see paper by T. Charters White in the " Journal of the Quekett Microscopical Club " for 1879.

Plate XXI. fig. 1. *a*, still cells × 400; *b*, green cell with chlorophyll vesicle, and reddish nucleus; *c*, a cell which had been dried six years, undergoing segmentation after revival; *d*, completed division; *e*, division into four; *f*, naked green zoospore; *g*, encysted zoospore; *h*, primordial cell, commencing division in two; *i*, encysted zoospore, which has deliquesced; *j*, primordial cell dividing in four; *k*, encysted zoospore in still condition; *l*, division of still cell into 8 cylindrical zoospores; *m*, escaped zoospore; *n*, division of encysted cell into 4; *o*, division into 8; *p*, division into 32; *q*, zoospores from the latter form escaped from mother-cell; *r*, large red still cell dividing into segments; *s*, red encysted cell; *t*, yellow-green still cell. All after Cohn.

Chlamydococcus nivalis. *Br. Rejuv. p.* 206.

Cells globose, red, at first with a hyaline border, which is the thickened epispore, which gradually disappears with age.

Size. Cells ·01-·03 mm. diam.

Rab. Alg. Eur. iii. 93.

Hæmatococcus nivalis, Ag. Icon. Alg. t. 31.

Protococcus nivalis, Ag. Supp. p. 13. Hook. Eng. Fl. v. p. 395. Mackay Hibern. p. 246. Hass. Alg. p. 335, t. 83, f. 2. Harv. Man. p. 182. Grev. Sc. Crypt. Fl. t. 231.

Palmella nivalis, Hook, in Parry's Voy. App. p. 328.

Tremella nivalis, Brown, in Ross Voy. Supp. p. 44.

Uredo nivalis, Bauer. Journ. Sci. and Art vii. p. 222, t. 6.

[redacted]

GENUS 38. **CHLAMYDOMONAS.** *Ehrb.* (1833.)

Macrogonidia ovate or oblong-rounded, green, delicately granulated, involved in a rather narrow hyaline tegument frontal extremity very obtuse, or somewhat truncate, with a contractile vacuole, and two cilia; posterior extremity with a large chlorophyllose vesicle, and with or without a red lateral spot. Microgonidia arising from repeated division of the cytioplasm of the macrogonidia, oblong or ovate, numerous, pale green or yellow, becoming brownish. Tranquil oospores globose, red or brownish, contents firm, colourless, hyaline.

" *Chlamydomonas* is distinguished from *Chlamydococcus* by the closely applied membrane (not standing away from the contents) of the old swarming cells, also by the absence of the little starch-vesicles in the interior, while, however, as is usual in most of the *Palmellaceæ*, a single large 'chlorophyll utricle' (starch utricle ?) exists in the interior. There is no central red nucleus, as in the gonidia of *Chlamydococcus*, but some species have a parietal red spot. The motion is affected by two cilia, as in *Chlamydococcus*. As in that genus, there is a growth of the gonidia during 'swarming,' which lasts over the day and night. There is also a formation of microgonidia. The species of this genus are doubtless very numerous, but the distinction of them among themselves, as well as from the swarming cells of many other Algæ, is very difficult without a complete acquaintance with the history of their lives. The species *Chl. obtusa*, occurs in the Rhine valley, near Freiburg, in sand pits, which are occasionally almost completely dried up in summer. The macrogonidia grow during their period of swarming from ·016 to almost ·033 mm. long; they are longish, of equal diameter on both sides, and very obtuse, almost truncated, having a colourless place at the ciliated extremity, presenting the form of a notch. In regard to other points, the contents are dark green, finely granular, with a large vesicle at the posterior extremity, a roundish lighter space in front of this, and no red point. They multiply by simple or double halving in several successive generations. Sometimes a further continuation of the division of the full-grown macrogonidia occurs, forming sixteen or thirty-two macrogonidia from ·005 to ·008 mm. long, of ovate shape and lighter colour, tending towards brownish yellow. The resting cells are globular, about ·025 mm. in diameter, at first green, subsequently light yellowish brown, finally flesh-red; they have a tough, colourless, and transparent membrane. Another species, *Chl. tingens*, occurs in enormous quantity in the puddles of the sandstone quarries at Lorettoberg, near Freiburg, in the month of March, in mild seasons sometimes even in January and February. The swarming cells are smaller than in the preceding, ·008 to ·016 mm. long, ovate, lighter green, likewise destitute of a red spot, and the membrane is more distinct in the old age. Increase by double, rarely by simple halving, in the former case with decussating sections.

"Several species of this genus, previously included in the animal kingdom, but nearly allied to *Glœococcus* and *Chlamydococcus*, present themselves in the beginning of spring, in such abundance that they produce a striking green colouration of the water; a few weeks later they vanish, leaving no trace, and are not noticed again throughout the whole year."—*Braun Rejuvenescence, p.* 215.

Chlamydomonas pulvisculus. *Ehr. Infus. p.* 64.

Macrogonidia ovate, twice as long as broad, or nearly; deep green, with a bright red lateral spot.

Size. Diam. ·0065-·013 mm.

Rabh. Alg. Eur. iii. 94. Cohn in Nova Acta. xxiv. t. 18, f. 28. Fresenius Beitr. 235, t. 11, f. 43-45. Pritchard Infus. 521, t. 18, f. 40, 51-54.

Diselmis viridis, Dujard. Zoophy. 342 iii. f. 20, 21.

In stagnant water.

" These creatures form a large portion of the green matter which colours the water contained in water-butts, ponds, and puddles in the summer and autumn, especially after a storm. Whenever these exist in large quantities, multitudes of them, and of their envelopes, rise to the surface of the water, and form a green stratum upon it."—*Pritchard.*

Plate XXI. fig. 3. *a*, swarmspore; *b*, *c*, encysted and undergoing division; *d* to *g*, glœocystis forms; *h*, resting cells, after Cienkowski × 400; *i*, stellate cyst, from Stein; *j*, individual differentiated; *k*, swarming × 600.

Genus 39. VOLVOX. *Linn.* (1758.)

Cœnobium sphærical, continually rotating and moving, looking like a hollow globe, composed of very numerous cells arranged on the periphery at regular distances, connected by the matrical gelatin; furnished with a red lateral spot, two contractile vacuoles, and two long exserted cilia, all circumscribed within a common hyaline vesicle. Propagation sexual or non-sexual. In the non-sexual certain distant cells greatly enlarge, divide into numerous parts, and evolve daughter- [redacted]

lower half of the plant the effect is obtained of looking into the inside of a glass sphere of crystalline purity and of absolute symmetry. The diameter of a full-grown Volvox is usually about 1-60", and individuals are to be found in each colony varying from this down to about 1-80". The *inner* surface of the sphere is studded at intervals with dark green points, not disposed irregularly, but so arranged that each is usually the centre of a group of six others, placed at the extremity of nearly equal radii. These green points are '*gonidia*,' each probably endowed with the potentiality of becoming a perfect Volvox, though only a certain number of them actually undergo that sequence of changes which results in their becoming fresh individuals resembling the parent sphere.

"Each gonidium is either sphærical or pyriform (in which case its pointed end is directed outwards), and contains, in its early stages at any rate, one or more contractile vacuoles disposed among a mass of granular endochrome, and stated by Busk to pulsate rhythmically once in about forty seconds. (Plate 23, Fig. 6.)

"At this period are also to be seen in the body of the gonidium one, two, or three—occasionally even more—brilliant colourless spots, from one of which is probably derived a nucleus which can be detected by the use of reagents at a later period.

"There is also often lodged within the substance of the zoospore a brown or red '*eye-spot*,' and all the eye-spots in an individual look, so to speak, one way.

"The apex of each gonidium is more or less produced into a transparent point, from which proceed two cilia several times as long as the gonidium itself, which pass through two minute pores in the outer cell wall, and move freely in the surrounding water. I am fortunate in having mounted a specimen of Volvox, in which these pairs of *foramina* are clearly shown, and the regularity of their disposition at a uniform angle to the equator of the sphere is striking. (Plate 23, Fig. 7.) It is, of course, by the combined action of these numerous pairs of cilia that the whole organism progresses. Of the direction of the resultant motion we shall speak shortly.

"Viewing the surface of the sphere with its convexity presented to the objective, we find, by very careful adjustment of light, that from each gonidium there runs to each of the six surrounding ones a fine thread, sometimes double, occasionally triple, always of extreme tenuity (Plate 22, Figs. 1 and 3), of *such* tenuity, indeed, as to be frequently invisible; but as the use of certain reagents often brings these lines into view where it had been previously impossible to detect them, and as they may be sometimes discerned for an instant when the eye is applied fresh and unfatigued to the microscope where even a moment later they seem to be absent, it may be assumed that the structure is universal, though often far too subtle to be detected. It is needless to say that no skill of the draughtsman can even suggest its infinite delicacy, while the figures given in books, not excepting the beautiful drawings in Ehrenberg's 'Infusionsthierchen,' exaggerate the strength of the connecting lines to the extent of grossly caricaturing the extreme fineness of Nature's own handiwork.

"To return to the gonidia and their history. A certain number of these in each individual are selected to produce a group of young Volvoces within the parent sphere. The books fix this number as usually four or eight; but out of twenty-five individuals now in the field of my microscope I find only three containing four incipient spheres of the second generation, while only one contains eight, and there are four containing five, six with six, ten with seven, and one with nine such progeny. Almost every Volvox, when first discharged from the parent

sac, and possessing a diameter of about 1-170", already contains a certain number of enlarged gonidia, destined in due time to become its own progeny. Not only so, but long before its discharge, and while yet it exists as a daughter-cell within the protecting cavity of the parent generation, these selected gonidia are already visible as spots larger and darker than their fellows. (Plate 22, Fig. 1.)

"The history of these selected gonidia, as it may be traced in a daughter-sphere recently cast forth to seek its fortunes in the world of waters around it, is as follows:—The enlarged gonidium is at first a flat, thin circular disc, appressed to the internal surface of the sphere, and being surrounded by *eight* of the ordinary zoospores, is derived from the coalescence of the two central ones out of a group of ten. (Plate 23, Figs. 1, 1*a*.) Shortly, this disc assumes a more distinctly oval form, with a slight constriction across its lesser diameter, in which stage it often much resembles a young Cosmarium. (Plate 23, Figs. 2, 2*a*.) It is soon seen to be clearly subdivided into four, and its thickness having grown *pari passu* with its superficies, the group now protrudes into the internal cavity of the parent-plant. (Plate 23, Figs. 3, 3*a*.) Repeated subdivision now goes on rapidly (Plate 23, Figs. 4, 4*a*), till the whole body assumes a sphærical form, a distinct cell wall being at the same time formed, which is revealed by careful illumination, and still more clearly by the use of reagents, as a hyaline sphere concentric to and of larger diameter than the green one within it, so that there appears to be a clear space or ring between the two when seen in section. (Plate 22, Fig. 5, 5*a*.) Finally, the young Volvox consists of a vast number of deep green granules closely packed together, and by mutual pressure driven to assume a more or less distinctly hexagonal form, and corresponding in number to the gonidia which are to stud its surface when its growth is completed. Shortly hereafter, the whole organism continuing to increase in size, clear spaces appear between the gonidia, *showing that the enlargement of the cell wall and its interspaces is outstripping that of the gonidia*, which are now approaching maturity. The interlacing connecting threads are developed simultaneously. (Plate 22, Fig. 1*a*.) During the whole process the centre of the young Volvox spheres continually recedes from the periphery of the parent, so that when the group of young ones has attained the full development of which it is capable in this stage they are often pretty closely packed in the internal [redacted]

greater part of the time it is regularly in the direction indicated, and the *point of rupture of the sphere will be at its north pole.*

"It is difficult to determine precisely how this rupture is accomplished, but I believe it to be by a special contraction of the walls of the parent, or of the invisible primordial utricle, *not* by the outward pressure of the daughter spheres, this force being evidently inadequate to produce the result where their number is small, whatever it may be when it reaches its maximum.

"Shortly before the emission of the young the cell commonly assumes a slightly pyriform shape, and then slowly opens at its apex, but *the aperture is of less diameter* than that of the young Volvoces, and as each of these passes out, the mouth of the bag is visibly stretched, and resumes its original size after each daughter sphere has escaped, so that it evidently possesses considerable elasticity, a property also made manifest by the fact that the normal form of Volvox may be considerably flattened by the pressure of a glass cover, and yet resume both its sphærical form and its motion when this pressure is removed.

"Moreover, the daughter sphere passes out *without rotating*, and from whatever cause it derives its impulse, this often suffices to drive the young Volvox clear of the mouth of the sac to a distance equal to several times its own diameter, in which position it pauses motionless for some seconds, and then, commencing to rotate gently, sails away, at first slowly, then more and more rapidly, to enjoy its independent existence.

"After the rupture of the sac, the gonidia near the edges of the opening are seen to quiver, from the action of the cilia, where they are partially freed from the support of the surrounding envelope, and the same thing occurs when they are forcibly torn from their attachment, in which case they may even move for awhile freely through the water.

"The general action of the cilia continues for some time, and the empty sphere rotates as before, its general direction being still from north to south, with the open end to the rear. After a time, which I cannot specify, the cilia cease to play, and the organism decays, having fulfilled its destiny in life.

"The birth of the young Volvoces is affected by various circumstances. Doubtless the process is, under natural conditions, most active in the early hours about dawn, when the analogous functions of similar organisms are well known to be most energetic, but in order to see the phenomenon in full vigour it is only necessary to place a number of mature parent-spheres, such as are found in every colony, in a shallow live-trough, and to bring them into a warm room. In an hour's time almost all the young plants will have been liberated. Light and heat stimulate the action, while cold and darkness retard it. The ciliary action is affected in a remarkable degree by altered external conditions. If a drop of water considerably colder than that in which the Volvoces are floating be allowed to flow in under the cover-glass, the whole are paralysed for some seconds, after which they slowly resume their motion. A sudden mechanical shock produces a similar effect. A sufficient degree of heat to make the water distinctly tepid to the feel causes instant and simultaneous death of the whole colony.

"During the day the majority of the Volvoces contained in a shallow vessel rise to the surface, although they avoid strong direct sunshine, while at night they retire in a cloud to the bottom.

"The astonishing number in which the spheres at times appear in some pool, and their equally sudden disappearance, have been frequently remarked. Doubtless a very slight change in external conditions suffices on the one hand to favour the development of countless thousands of

young plants, and on the other, either to destroy the vitality of the whole colony or to drive it to seek refuge in deeper water.

"A curious instance of this sensitiveness to varying conditions of light and heat occurred to myself. I had two shallow vessels in a north window, each containing a goodly supply of Volvox. Cold and inclement weather, which prevailed for weeks together, seemed to check their increase, for I found but few young spheres from day to day among the older ones. Thinking that a moderate degree of warmth would tend to increase my colony, I transferred one vessel, fortunately not both, to the floor of a warm greenhouse. In forty-eight hours all were dead, and in a few days scarcely a vestige remained of the countless corpses which had copiously strewed the bottom of the glass.

"We must now revert to the minute structure of the mature parent-sphere, which has been exhaustively studied by Cohn, Busk, and Williamson.

"In the outset it should be stated that the last-named observer believes that there are two distinct forms of Volvox, in one of which the peculiar structure which I am about to describe exists, while it is absent from the other. Busk disputed the accuracy of Williamson's observations on this point, but in an appendix published subsequent to the body of his essay he states that he has detected this same structure in specimens from Manchester, but *not* in his own.

"I have failed to develop it by the means recommended by Williamson, but have succeeded in making it evident enough in a great number of specimens from Sutton, by the use of these reagents, and especially by the application of aniline purple, an invaluable auxiliary in the examination of minute vegetable cell-structures.

"This substance stains the protoplasmic elements of such structures to a colour which appears deep purple by direct light and crimson by dark background illumination, and reveals details which are wholly invisible without its use.

"The colour is, however, greedily absorbed by some of the materials used by the microscopist, so that a judicious choice of these is necessary to ensure success. Objects stained in this manner are, for instance, rapidly bleached if mounted in gold-size cells, and I have for the present adopted zinc-white in its place. Among other reagents which I have used are eosin, iodine, iodised glycerine, carmine solution, potassium [redacted]

only made evident by the action of reagents. (Plate 22, Fig. 2.) He regards the globe of Volvox as a 'hollow vesicle, the walls of which consist of numerous angular cells filled with green endochrome, &c., the intercellular spaces being more or less transparent,' and the ciliated zoospore as representing the endochrome of a cell having two walls, the *internal* one being separated from the outer cell-wall, except at a few points where it is retained in contact by the connecting filaments, and the *external* one forming the hexagonal divisions on the surface. He further holds that the periphery of the sphere, when seen in section, has an appreciable thickness, its inner margin being definite and parallel to the outer one; and that the sides of the hexagons being continued downwards through the thickness of the outer membrane, the appearance of all these structures, if they could be seen simultaneously, would be that shown in Plate 23, Fig. 6.

"Even in deeply stained specimens I have never been able to detect the existence of these hexagons as other than an entirely *superficial* structure, and at present my impression is that the hexagonal structure has a different significance.

"In the very early stage of Volvox-life the embryo gonidia are encased in a distinct transparent outer-sphere. (Plate 23, Fig. 5, 5*a*.) At a later period owing to the more rapid growth of the gonidia than of the case, the latter closely invests the former, which are, in fact, embedded in it. In the next stage, if not in the earlier condition, by the continued growth of the gonidia at a *greater rate* than that of the containing sphere, they are so closely appressed as to assume the hexagonal form, and the interstices must of necessity consist of a thin film of the substance of the containing sphærical envelope, moulded, so to speak, into corresponding forms. But now the diameter of the young Volvox, which is by this time sent forth on its independent career, rapidly increases, the gonidia assuming their sphærical or pyriform shape as their mutual pressure diminishes, and being hourly separated by greater intervals. If, now, the actual formative matter of the sphere receives no further or only a disproportionate increment, but is gradually attenuated by continued expansion, as a soap bubble is distended by blowing into it, the hexagonal lines into which it has been moulded by the previous mutual pressure of the embryo gonidia will be gradually stretched in all directions into finer proportions; and just as this figure is that which is *necessarily assumed* by a number of sphærical bodies under mutual pressure, *so* the most economical disposition of this particular part of the Volvox-structure will necessitate its constant attenuation into hexagons of ever-increasing delicacy. (Plate 22, Figs. 1, 3; Plate 23, Fig. 7.) If the process be continued long enough, it may finally result in the structure becoming too filmy to be detected by any microscopical observation; and it is worth noticing that it is usually in spheres of small or medium diameter that the hexagonal divisions can be developed, and not in those of the largest size. Such appears to me at present to be the rationale of the formation of this structure.

"The internal cavity of the sphere is said to be filled with a 'mucilaginous fluid.' If a Volvox be ruptured under a cover-glass, and aniline purple introduced by capillary attraction, the colour seems to be for a while repelled at that part which is in front of the rupture, and to flow round it on either side. It is only after a considerable time that it gradually penetrates this space, and brings out, by staining it of a deep purple tint, a mass of hazy matter, from which proceed streaks or lines radiating more or less regularly from its south pole. This structure, to which I do not think attention has been hitherto called, is also sometimes developed in deeply stained specimens within the slightly

ruptured sphere, and seems to show that there is a denser layer of thick matter, whatever its nature may be, disposed in a somewhat regular manner, being concentrated near the south pole of the axis of rotation, whence it spreads over the inner surface in streaks resembling the lines of longitude on a terrestrial globe.

" Both from its position and from the rapidity with which it is stained by aniline purple, without which its existence is apparently absolutely undemonstrable—(in which respect it is in marked contrast to the outer cell-wall, which latter is only faintly tinted by somewhat prolonged application of the reagent, and then only where the hexagonal structure exists)—I have no doubt that this inner layer is the true 'primordia utricle' of the cell, and possesses that character of vital and formative matter which distinguishes this element of cell-structure from the outer wall, which, on the other hand, probably consists of cellulose or some similar compound. Probably the arrangement of this inner layer, in radiating lines or ribs, contributes to the elasticity of the fabric, whereby it is enabled to open at a given point for the escape of the young, and to contract again after their emission.

"The increase of individuals by the means already described is strictly an instance of subdivision.

" But *Volvox globator* also affords an instance of true alternation of generations. As may probably be affirmed of all living organisms, its life-history would be incomplete without a process of sexual reproduction, and accordingly, after a long sequence of asexual generations, a strictly sexual process intervenes, from which result certain spores destined to lie dormant for a while, and, like the zygospores of the Conjugate Algæ, to resist vicissitudes of condition and climate through the rigours of winter, and then to produce the parent form in the succeeding year, when external conditions again favour its development.

" Cohn fully traced the various stages of this process, and described them in the 'Beiträge zur Biologie der Pflanzen' (1875, Vol. I., Heft. 3), and in the 'Annales des Sciences Naturelles' (4 ième Ser. Bot., Tom. V., 323); and his observations have been more or less confirmed by other investigators, especially by Carter (Ann. Nat. Hist., 3rd Ser., Vol. III., 1859, p. 1), and more recently, in 1877, by a French botanist, M. F. Henneguay.

develop into *plates or discs of cells, not* into spheres, and ultimately resolve themselves into bundles of naked elongated cells, in which the chlorophyll is transformed into a reddish pigment, each with a long colourless beak, with a red 'eye-spot' and two cilia. (Plate 22, Fig. $5a$, a^2.) About the same time that the oosphere is mature these antheridia begin to move from the combined action of their cilia (Plate 23, Fig. 10), and then break up into separate antherozoids, which finally become free, and move rapidly within the cavity of the sphere. (Plate
2 2~~3~~, Fig. $5a^3$.) Assembling round the oospheres, they penetrate the envelopes of the latter (Plate 22, Fig. 4), coalesce with their contents, and the *oosphere*, thus fertilised, becomes an *oospore*, which soon develops a cell-wall covered with conical stellate projections, and a second smooth internal membrane. (Plate 23, Fig. 11.) The chlorophyll now gradually disappears, and is replaced by an orange red pigment. In this condition the oospore constitutes the *Volvox stellatus* of Ehrenberg. It is liberated by the decay of the parent-cell, and sinks to the bottom of the water to hibernate. The subsequent history of these bodies has been traced by Cienkowski, and more recently by Henneguay ("Journal de Micrographie," Vol. II., p. 485, Bull. Soc. Philomath, Paris, July, 1878).

"Cohn believed that they must be dried up before germination was possible. Henneguay has now observed that this is not so. In spring the outer case of the spore (exospore) is ruptured, and the swollen contents (endospore) project through the opening. The contents then divide gradually into two, four, eight, sixteen, or more small cells, which become bright green, each meanwhile acquiring two vibratile cilia while still contained within the inner membrane of the spore. The cells, at first in close apposition, separate further from one another by interposition of gelatinous hyaline matter, the outer membrane disappears, the cilia become active, and the young Volvox, already containing some elements larger than the others, and destined, in due course, to produce daughter-spheres, moves freely through the water. 'The spores of Volvox, therefore, germinate in water, and each of them produces a single colony by a process of segmentation identical with that which gives rise to a daughter-colony at the expense of a cell of the mother-colony.'

"The sequence of asexual generations is repeated for many months, and in the following autumn the alternation of generations is again completed by the intervention of the processes just described."

Volvox globator. *Linn. Syst. Ed.* x.

Larger cœnobia, with very numerous cells (12,000), always with daughter-cœnobia enclosed within the mother, evolved without sexuality; fructification diœcious; the male cœnobia nourishing numerous red fascicles of spermatozoa; the female cœnobia originating 20-40 sexual cells, which after fecundation are resolved into as many red globose oospores, surrounded by a hyaline stellate epispore (=*Volvox stellatus*, Ehr.).

SIZE. Cœnobium as much as 1 mm. diam.

Ehrb. Infus. 68, t. 4. Dujardin Zoophy. 312, iii. f. 25. Stein Infus. p. 46. Rabh. Alg. Eur. iii. 97. Pritchard Infus. 526, t. 20, f. 32-47. Busk. Trans. Micr. Soc. 1853, p. 31. Williamson Trans. Micr. Soc. 1853, p. 45. Currey Ann. Nat. Hist. 1859, p. 5. Dr. J. B. Hicks in Micro. Journ. 1861, p. 281; in

Popular Science Review, vol. v. p. 137. A. W. Wills in Midland Naturalist, Sept.-Oct., 1880. A. Bennett in Popular Sci. Rev. 1878, p. 225.

Sphærosira volvox, Ehr. Infus. (male). Pritch. Infus. p. 526. Williamson in Popular Sci. Review, vol. ix. p. 225.

Volvox stellatus, Ehr. Infus. (oospore).

In clear pools, ponds, &c.

The relationship of *Sphærosira volvox* to *Volvox globator* has not been satisfactorily determined (see Williamson), although there remains no doubt of the existence of relationship. Some regard it as the male form, but Professor Williamson considers it a peculiar condition of *Volvox*.

For details of a successful experiment in keeping *Volvox* during the winter see N. E. Brown in Gardener's Chronicle (1879 p. 599) and "Ponds and Ditches," by M. C. Cooke, p. 63.

Plate XXII. figs. 1-3. *Volvox globator*, after A. W. Wills; 4-5, after Cohn. Explanation given above.

Plate XXIII. figs. 1-5. After A. W. Wills; 6, ideal section after Williamson; 7, after Wills—also fully described above; 8-9, × 300 after Stein; 10, complete antheridium; 11, stellate resting spore or oosphere × 400 (*Volvox stellatus*); 12, spermatozoids × 600.

Plate XXIV. Male plants of Volvox, known as *Sphærosira volvox*, after Williamson. *Fig.* 1, cœnobium; 2, protoplasmic mass from the cœnobium, containing granules; 3, mass divided in two; 4, the same divided into four; 5, the same divided into sixteen; 6, further division into thirty-two, provided with movable cilia; 7, discoid family revolving within its mother-cell.

Volvox minor. *Stein Infus. p.* 47.

Cœnobia and the number of cells smaller; the number of daughter-cœnobia evolved without sexuality within the mother,

GENUS 40. EUDORINA. *Ehrb.* (1831.)

Cœnobium oval, involved in a common tegument; cells green, globose (16-32), enclosed within a single membrane, bearing vibratile cilia, often with a red spot (eye-spot), distributed around the hyaline sphere at equal distances apart. Asexual propagation in all the cœnobia, the cells of which are divided into 16-32 parts, and soon evolved into new cœnobia. Sexual propagation in all the cœnobia, the cells being converted into motionless oospores enclosed in a narrow epispore, afterwards becoming red.

The most complete account we possess of the life-history of *Eudorina* is that by H. J. Carter (*Ann. Nat. Hist.*, Oct., 1858), of which the following is a summary:—Unable to recognise this organism in its simplest form as a solitary cell, nor any stage of segmentation prior to the third degree of duplicative subdivision into 16 cells, he commences from this period.

At this time, which we call the first stage, the *Eudorina* consists of an ovoid green body, partially divided into the number of cells just mentioned, each of which is provided with a pair of cilia, which project through a thin gelatinous envelope that surrounds the whole mass. It is now about 1-1100ths of an inch long, *i.e.*, not more than the diameter of the *Chlamydococcus* cell, and swims by means of its cilia, with the small end foremost, and with a rotatory motion on its longitudinal axis, as often from right to left as from left to right. An eye-spot is also present in each of the four anterior cells, but seldom visible in the rest at this period.

As development progresses each cell is provided with a sphærical, translucent utricle, an eye-spot midway between the cilia and the opposite end of the cell, a contractile vesicle at the base of the cilia, and the pair of cilia themselves.

During the second stage each of the cells again undergoes duplicative division, and the whole organism becoming larger, they are separated from each other, and being no longer subject to compression, become sphærical and enclosed respectively within distinct transparent capsules. The *Eudorina* is now six times as long as in the first stage, and contains 32 green cells, which are evidently situated between two large ovoid, colourless, transparent cells, one of which bounds a similarly shaped cavity in the centre of the *Eudorina*, and the other is the original cell wall, round which again is the newly secreted envelope. Thus we see that the *Eudorina* is derived from a simple (daughter) cell, and that its green cells have resulted from a duplicative subdivision of the green matter which lined the cavity of this cell. Arrived at this state, which we shall see is that of maturity, we also observe that the posterior part of the envelope becomes crenulated, apparently from flaccidity.

After this, however, it again presents another phase, which may be called the third, or last, stage of development. Here each cell again undergoes a rapid duplicative subdivision into 16 or 32 cells, which, in the group, assume a more or less oblong figure respectively, and thus the *Eudorina's* length is increased to 10 times that of its first stage. The internal structure now gradually breaks down before the external envelope, when for a short time the groups may be seen swimming about the cavity thus formed, till at last the envelope bursts and they become liberated. What becomes of them afterwards he could not state from observation, but the green cells having been greatly reduced in size by the latter sub-

divisions it is probable that many of the groups, if they do not form new individuals, sooner or later become disintegrated, and the *Eudorina* thus eventually perishes.

When, however, the process of impregnation takes place, the division stops at the second stage, that is when the *Eudorina* consists of 32 cells of the largest kind, each of which is about 1-1866th of an inch in diameter within its capsule, which is therefore a little larger. The process is as follows:—

At a certain period after the second stage has become fully developed the contents of the *four* anterior cells respectively present lines of duplicative subdivision, which radiate from a point in the posterior part of the cell (in the subdivision of other cells the lines of fissiparation tend towards the centre of the cell). These lines, which ultimately divide the green contents of the cell into 64 portions, where the division stops, entail a pyriform shape on the segments, from whose extremities a mass of cilia may be observed waving in the anterior part of the cell of the parent, while yet her own pair of cilia are in active motion, and her eye-spot still exists *in situ* on one side of her progeny, thus showing that the latter may be almost fully formed before the parent perishes. At length, however, this takes place, and the progeny (*Spermatozoids*) separate from each other, and finding an exit, probably by rupture, through the effete parent cell and her capsule, soon become dispersed throughout the space between the two large ovoid cells mentioned, where they thus freely come into contact with the capsules of the twenty-eight remaining, or female cells.

The form of the spermatozoid now varies at every instant from the activity of its movements, and the almost semifluid state of its plasma. Its changes, however, are confined to elongation and contraction; hence it is sometimes linear-fusiform, or lunular, at others pyriform, short, or elongate. The centre of the body is tinged green by the presence of a little chlorophyll, while the extremities are colourless, the anterior one bears a pair of cilia, and there is an eye-spot a little in front of the middle of the body, also probably a nucleus. It is about 1-2700th of an inch long and about one-fifth as broad.

Once in the space mentioned, the spermatozoids soon find their way among the female cells to the capsules, of which they apply themselves most vigorously and pertinaciously, flattening, elongating, and changing themselves into various forms as they glide over their surfaces, until they [redacted]

The author cited then goes on to explain how he conceives the other stages of the *Eudorina* are passed, which he had not the opportunity of observing. The whole memoir is one of great interest, and will well repay perusal by those who are investigating this subject.

Eudorina elegans. *Ehrb. Monats. Berl.*, 1831, *p.* 78.

Cœnobia oval, cells usually 32, globose, either scattered or quaternate, eight at each pole, distributed in three parallel circles, at equal distances from each other, around the periphery of the cœnobium.

SIZE. Cœnobium ·04-·15 mm. long. Cells ·018-·022 mm. diam.

Rabh. Alg. Eur. iii. 99. Ehrb. Infus. 63, t. iii. Pritchard Infus. p. 520. Carter, in Ann. Nat. Hist., Oct., 1858.

Pandorina elegans, Dujard. Zoophy., p. 317.

In standing water.

Formerly found at Hackney and Hampstead, most abundant in the spring of the year, but doubtless quite extinct at both places. "Clusters are often seen," says Pritchard, "in such amazing numbers along with *Volvox* and *Chlamydomonas pulvisculus* as to render the water of a decided green colour, especially towards the edges."

Plate XXVI. fig. 1. *a*, 16-celled family; 2, sixteen-celled family dividing into a 32-celled family; 3, part of a family, showing division in pairs; 4, 32-celled family divided into daughter-families; 5, one-celled daughter-family. All after Stein. 6, colony with three spermatic cells, having burst; 7, spermatic cells × 400; 8, spermatic cell × 800; 9, spermatozoids × 800. After Carter.

GENUS 41. **PANDORINA.** *Ehrb.* (1830.)

Cœnobium globose or subglobose, invested by a broad colourless hyaline tegument; cells green, granulose, globose (16, 32, or 64), included within a single rather thick membrane, bearing two vibrating cilia, with or without a red spot, aggregated in a botryoid manner.

Propagation the same as in *Eudorina.*

Henfrey's emended character of this genus was in the following terms:—"Frond a microscopic, ellipsoidal, gelatinous mass, containing, embedded near the periphery, sixteen or more biciliated, permanently active gonidia, arranged in several circles perpendicular to the long axis of the frond. The gonidia almost globose, with a short beak-like process, a red spot, and a pair of cilia which project through the substance of the frond to form locomotive organs upon its surface. Reproduction—I., by the conversion of each gonidium into a new frond within the parent mass; II., by the conversion of the gonidia into encysted resting spores, which are set free and (?) subsequently germinate to produce new fronds."—*Quart. Micro. Journ.* (1856), *p.* 49.

Pandorina morum. *Ehr. Inf. p.* 53, *t.* II. *f.* 33.

Cœnobium globose. Cells green, 16-32, arranged about the periphery. In the forms which produce the resting spores, the cells are crowded together in the centre. Resting spores after becoming encysted bright red.

SIZE. Cœnobium ·2 mm. Cells ·01-·015 mm. diam.

Rabh. Alg. Eur. iii. 99. Henfrey Micr. Trans. (1856) p. 49, t. 4. Pringsheim Monatsb. Berlin, Oct., 1869. Ann. Nat. Hist. v. (1870) p. 272. Pritchard Infus. pp. 157 and 517, t. xix. fig. 59-69. Braun Rejuv. pp. 169-209.

In standing water.

"Fronds hyaline from about 1-80'' downwards. Gonidia either 16, and then arranged in four circles of 4, or 32 and then in five circles, two at the poles of 4, and the intermediate three of 8 gonidia, which in the perfect form stand near the periphery, and wide apart. In the forms which produce the resting spores the gonidia are crowded together in the centre. The gonidia are green, but the contents of the resting spores, after they have become encysted, are converted into oily and granular matter of a bright red colour."—*Henfrey.*

Pringsheim, in his memoir "on the pairing of Zoospores,"* makes special reference to this species. He says that asexual reproduction takes place in *Pandorina,* as in other multicellular Volvocineæ, by the formation of a perfect young plant in each cell of the mother plant. By the gradual dissolution of the general envelope and of the special membrane of the mother-cells, the young plants become free, and escape. In sexual reproduction, as in the asexual, the membrane of the old plant swells, and sixteen young plants are formed. The young plants, however, are (at least in part) not neuter, but sexual, and either male or female. Whether the mother plant is monœcious or diœcious is difficult to determine, because the male and female plants are externally alike, and can hardly be distinguished with certainty during copulation. There is no striking difference in structure between the sexual and asexual plants, although, amongst the former, plants with less than sixteen cells, [redacted]

from other zoospores. At their colourless apex they exhibit, like other zoospores, a red body placed on one side of the apex, and two long vibrating cilia, by which they move in the manner common to zoospores. The individual zoospores exhibit no marked differences, except that they vary in size within tolerably wide limits, but not in a manner to indicate the existence of two different sorts.

Amongst the groups of isolated zoospores of different sizes some are at last seen to approach one another in pairs. They come into contact at their anterior hyaline apex, coalesce with one another, and assume a shape resembling a figure of 8. The constriction which marks their original separation disappears by degrees; and the paired zoospores form at last a single large green globe, showing at the circumference no trace of their original separation. It may be seen, however, that the globe is larger than the individual neighbouring zoospores, that it has a strikingly enlarged colourless mouth spot, with two red bodies on the right and left, and that it is furnished with four vibrating cilia originating in pairs near the two red spots. The four cilia, however, soon become motionless, and together with the red spots disappear.

This act of conjugation occupies some minutes from the first contact of the zoospores to the formation of the green globe. The latter becomes the oospore, which, after growing slightly larger, and assuming a red colour, germinates after a long period of rest, and brings forth a new *Pandorina*. There is hardly any appreciable difference, except in size, between the male and female zoospores. Most frequently a small zoospore pairs with a larger one; but two of equal size often unite. Probably both the females and the males vary much in size, the former more so than the latter.

With regard to the entire plants from which the zoospores are produced, there is little doubt that those of the largest size are females; but the sex of the smaller and middle-sized ones cannot be determined with any certainty. The germination of the oospore is like that of other *Volvocineæ*, especially resembling in its early stage the germination of the resting spores produced by the microgonidia of *Hydrodictyon utriculatum*. The oospore bursts, and produces a single large zoospore (in rare cases two or even three), which divides into sixteen cells, and becomes a young *Pandorina*.

Plate XXVII. fig. 2. *Pandorina morum*—*a*, a very small family; *b*, *c*, sixteen-celled families; *d*, eight-celled family; *e*, solitary cell; *f*, the same, further magnified, showing process of subdivision; *g*, 32-celled family; *h*, small family undergoing division; *i*, 16-celled family divided into sixteen daughter families. All after Stein × about 500.

GENUS 42. **GONIUM.** *Müller*. (1873.)

Cœnobium quadrangular, tabular, angles rounded, formed from a single flat stratum of cells, girt by a broad hyaline plano-convex tegument. Cells 16 (central 4, peripherical 12), polygonal, bright green, becoming with age disordered, granulose, connected by the produced angles, chlorophyllose vesicle central, furnished with colourless contractile vacuoles, and two long exserted cilia.

Propagation by repeated division of the cytioplasm.

Gonium pectorale. *Mull. Vermium, p.* 60.

Cœnobium flattened, quadrangular, composed of 16 green cells, furnished with vibratile cilia.

SIZE. Cœnobium, from ·05 mm. Cells from ·01 × ·007 mm.

Rabh. Alg. Eur. iii. 99. Müll. Anim. Inf. t. 16, f. 9-11. Ehrb. Infus. 56, t. 3, f. 1. Dujard. Zoophy. p. 318. Focke Studien, 30, t. 4, f. 7, 8. Fresen, Abhand. der Senck, p. 191, t. 8. Cohn Nova Acta, xxiv. p. 169, t. 18, f. 9-27. Pritchard Infus. p. 518.

In stagnant water.

The fullest account of *Gonium* is that by Cohn, published many years ago, but nothing has been added to its history since. The following is a summary of his observations:—

Each family is invested with a colourless mucous sheath which is difficult to be seen without adding some colouring matter to the water, as there appears to be no tegument. Seen from above, it is a quadrilateral tablet with rounded corners, or from the side elliptical. The primordial cells are sixteen in number, four occupying the centre disposed as a square, and three on each side external to these. The central cell of the three on each side is set a little nearer towards the centre. The cells are somewhat polygonal, the four central being hexagonal, and the twelve external pentagonal. When young the angles can scarcely be distinguished. This regular polygonal form indicates that each cell is surrounded by a firm membrane, which retains them in a fixed form. The investing membrane may also be detected at the angles of the cells, from each of which it is extended in a short tubular process, which is quite colourless. These processes are joined to those of contiguous cells, so as to link them all together. These processes are not visible in immature families, being subsequently developed.

In other points the organization of the cells resembles *Chlamydomonas*. Their contents consist of protoplasm, coloured by chlorophyll, when old containing numerous corpuscles, a central darker corpuscle, and often several vacuoles. Each cell is furnished with two cilia, which proceed [redacted]

able, a single colony may on the second day develop 16, on the third 256, on the fourth 4,096, and at the end of the week 268,435,456 other organisms like itself.

It has been supposed that some of the cells become detached from the mature cœnobium and pass into a resting condition, but this has not been positively demonstrated, so that fissuration is the only mode of reproduction at present known.

A fuller abstract of this paper by Cohn (from "Nova Acta," Vol. XXIV., p. 169) is given in Pritchard's Infusoria (p. 153).

Plate XXVII. fig. 1. *Gonium pectorale*—*a, b, c*, families in different positions × 400; *d, e*, the same, rather more highly magnified; *f*, family before division; *g*, family of 16 cells divided into 16 daughter families; *d* to *g* after Stein.

GENUS 43. **STEPHANOSPHÆRA.** *Cohn.* (1852.)

Cœnobium throughout its whole life rotating and moving, composed of 8 green cells, bearing two vibratile cilia, disposed at equal distances around a circle, enclosed in a common colourless hyaline, globose vesicle.

Propagation, both by macrogonidia arising from the eightfold division of the green cells, bearing two cilia, with a lateral red spot, congregated in families of eight; and by microgonidia, very much smaller, produced by multiplied division, at first revolving within the common vesicle by the action of four cilia, afterwards free, escaping singly.

Stephanosphæra pluvialis. *Cohn Hedwigia* I., *p.* 11.

Cells globose, elliptic or fusiform, often at each extremity spreading out in mucous rays.

SIZE. Cœnobium ·026-·052 mm. Cells ·006-·012 mm. diam.

Rabh. Alg. Eur. iii. 100. Currey in Micr. Journ., 1858, vi. p. 131, t. 6, f. 1-27. Cohn Zeitschr. fur Wiss. Zool., 1852, iv. p. 77. Archer Micr. Journ., 1865, p. 116. Pritchard Inf. p. 529, t. 19, f. 38-58.

In hollows of rocks, and in pools after rain.

Stephanosphæra was first observed in 1850 in Germany, and since in many places, including the British Isles.

It consists of a hyaline globe, containing eight green primordial cells, arranged in a circle in its equator. The globe rotates upon an axis perpendicular to the plane in which the primordial cells are arranged, and moves actively in space by the aid of cilia, two of which proceed from each of the primordial cells, and pierce the hyaline envelope. The primordial cells divide first into two, then four, and lastly into eight portions; these portions separate from each other in a tangential direction, thus forming a disc round which a cellular membrane is developed. Two cilia are produced upon each segment, and thus eventually eight young individuals are formed, which ultimately escape by fissure of the

parent globe. This process was observed to occupy about twelve hours. Cohn also observed the division of each of the eight primordial cells into a great number of microgonidia, which swarm within the globe, and escape from it. Under certain circumstances each of the eight cells secretes a cellular covering, and swims about in the interior of the globe in the form of free *Chlamydococcus*-like cells. Eventually they escape either by fissure of the globe or by its gradual dissolution, lose their cilia, form a thicker membrane, become motionless, and accumulate at the bottom of the vessel. If the vessel be permitted to become dry, and afterwards filled with water, motile *Stephanosphæra* reappear, from which it seems probable that the green globes are the resting cells.

The resting cells vary much in size, and it is supposed that they grow considerably after attaining a state of rest. The colour is deep green, sometimes yellowish or olive, and they possess a nucleus.

The dried resting spores absorb water, and their contents gradually fill up the cavity of the containing membrane, and become cloudy and granular; the border becomes yellowish, and the red colouring matter is contracted in the centre. The cells then begin to divide and pass through successive stages, as shown on the plate (Plate 28, figs. 13 to 17). The four daughter-cells begin to quiver, and endeavour to separate from each other. Two cilia are now apparent at the pointed extremity of each of the four cells (fig. 19), by the action of which the group begins to move as a whole; utlimately all trace of the enveloping membrane disappears, and one by one the daughter-cells escape and become free. At the moment of escape their diameter never exceeds ·01 mm., but they soon enlarge to a diameter of ·013 to ·015 mm.

The length of time which elapsed between the immersion of the dried resting spores and the first appearance of the motile cells varied from nine to twenty-four hours. It was observed that those resting spores which did not produce zoospores within six days never did so afterwards, although they continued to live, and seemed perfectly healthy. Zoospores produced in November did not advance beyond the first stage. Others produced in March remained only a few hours in that condition, after which time a delicate membrane was formed round the body of the primordial cell; this membrane was at first closely attached to the cell, but became gradually enlarged, by absorption of water, into a colourless enveloping vesicle, usually globular,

[redacted]

coloured contents of the individual portions become drawn back towards the periphery in centrifugal direction, a colourless plasma remaining about the central point; this disappears at first in the centre, a cavity is formed in the middle of the disc, and as this enlarges the eight portions assume the form of a wreath, consisting of eight globular or ellipsoid bodies in close contact, usually not exactly in one plane, owing to the outer membrane not having expanded in proportion to the enlargement of the plasma. The original cilia continue active, causing the motion of the whole organism, until the eight portions are completely individualized, and then their motion ceases. The separate parts of the plasma now form eight independent but closely packed membraneless primordial cells. Shortly afterwards a delicate membrane common to them all is secreted beneath the mother-cell membrane round the disc formed by the primordial cells. This membrane is at first in contact, but afterwards becomes further and further removed as it swells and tends to assume a globular form. By the motion of the cilia the mother-cell membrane is thrown off, and the young family escapes into the water. When the Chlamydococcus-like unicellular *Stephanosphæra* has commenced its division early in the evening, the division into eight is perfected during the night, and early in the morning the young family quits its cast off mother-cell membrane.

In the course of the day the individual primordial cells and their common investing membrane grow until the latter attains a diameter of ·04 to ·048 mm. During this growth the shape of the primordial cells is changed by the formation of various prolongations, but in the course of the afternoon they again become round, and during the evening division commences in them precisely similar to the process in the unicellular *Stephanosphæra*. On the following morning we find eight young families. It is calculated that in eight days, under favourable circumstances, 16,777,216 families may be formed from one resting cell of *Stephanosphæra*.

We have given but a barren outline of the history of this little plant, but for further information must refer the student to Cohn's Original Memoir in Siebold and Kolliker's Zeitschrift fur Zoologie, 1852, p. 77. Translated in the "Annals of Natural History," 2nd series, Vol. X., pp. 321 and 401. Also Cohn and Wichura's subsequent memoir "Ueber Stephanosphæra" in Nova Acta Acad. Leop. Car., 1857, part I., Vol. XXVI. Of which an abstract is given by Currey in "Quarterly Journal of Microscopical Science," Vol. VI. (1858), p. 131. Also an admirable summary by Archer in the "Quart. Journ. of Microscopical Science" for 1865, p. 117, with additional observations by himself.

Plate XXVIII. fig. 1. Polar view of family with globose primordial cells; 2, equatorial view, with fusiform primordial cells ending in mucous filaments; 3, the same, with primordial cells collected on one side; 4, commencement of formation of macrogonidia; 5, all eight primordial cells divided in fours; 6, division advancing so that each primordial cell consists of eight cuneate segments; 7, further advanced in division, movement in the mother-cell having commenced; 8, division completed, eight young individuals revolving in the mother-cell; 9, the eight original primordial cells broken up into microgonidia; 10, young *Stephanosphæra*, (figs. 1 to 10 × 300); 11, microgonidia after exit from mother-cell × 500; 12, full-grown resting cells; 13, commencement of division in resting cell; 14 to 19, successive stages in division of resting cell; 20 to 22, naked zoospores; 23, 24, encysted zoospores; 25 to 27, division of encysted zoospores; 28, young eight-celled family resulting from division of encysted zoospore; 29, 30, young families, all after Cohn × 400; 31, amœboid condition of primordial cells, after Archer.

Order II. *ZYGOPHYCEÆ.*

Either unicellular or multicellular Algæ, with terminal vegetation, and destitute of true ramification. Cells single, or segregate, or geminate, or united in a series. Chlorophyll-mass for the most part distributed in plates, or bands, including one or more amylaceous granules.

Multiplication by division of the cells in one direction.

Propagation by zygospores resulting from the conjugation of two cells.

Consult here Dr. A. De Bary's "Untersuchungen uber die Familie der Conjugaten." Leipzig, 1858.

Family I. DESMIDIEÆ.

Unicellular Algæ. Cells for the most part compressed, single, or segregate, or geminate, or a larger number united in a band, or filament; variable in form, usually constricted in the middle, so as to constitute two symmetrical semi-cells.

This large and interesting family is designedly excluded from the present work, as it is proposed to treat them separately. As so many students confine themselves exclusively to this family, this proposal will doubtless commend itself. The excellent text book by J. Ralfs has long been the standard for English students, and would be so still but for its scarcity, and the large number of additions in the interval since its publication.

Family II. ZYGNEMACEÆ.

[redacted]

We append here De Bary's scheme of classification of this Order, which he terms "Conjugatæ."

"Cells of limited growth, propagated by unlimited repeated bipartition (tripartite in *Craterospermum*) in the same direction, free or connected in single rows, chlorophyll in parietal bands, axile plates, or radiating bodies, in pairs. Cell-wall cellulose or gelatinous.

"*Fructification.* By copulation a zygospore arises of a different form from its mother-cells. No asexually produced swarmspores.

"SUBDIVISIONS.

"I. *Mesocarpeæ.* Zygospore the shape of the mother-cells, not contracted, separating by three or five partitions into a central firm-walled resting-spore and two or four lateral decaying cells. (Cells cylindrical, united in threads, with axile plates of chlorophyll.)

"II. *Zygnemeæ.* Zygospore undivided and mostly contracted, passing into the resting condition, afterwards developing into a germ-cell divided into a basal cell, and a thread-cell capable of division. (Cells cylindrical, united in threads.)

"III. *Desmidieæ.* Zygospore of the form of the *Zygnemeæ*, developing into a germ-cell, or divided into 2 or 4, each of which separates into two equal daughter-cells capable of division. (Cells usually consisting of two symmetrical halves, of very various form, free or united.)"

We have adopted a similar arrangement, with the exception of the present exclusion of the *Desmidieæ*, and the addition of a small subfamily, the *Gonatonemeæ*, which dates from a period subsequent to De Bary's Memoir.

Conjugation in the present family is the union of two cells, either of separate filaments, or of the same filament, the result being the formation of a zygospore. The cells containing the male and female element cannot at present be distinguished from each other, although De Bary states that he has observed a constant difference between the fertile and sterile cells of a species of *Spirogyra.* Usually all the cells of one filament appear to be either giving or receiving cells, so that the male and female filaments would seem to be distinct, but this requires more certain confirmation, inasmuch as in such of the species of *Spirogyra* as exhibit lateral as well as scalariform conjugation, all the cells in one filament cannot be of the same kind.

"The first perceptible change in a cell about to produce a resting-spore appears to be a loosening of the primordial utricle from the outer wall, and a contraction of it upon the cell-contents, which thus are crowded together and more or less deformed. Simultaneously with this, or a little after or before it, the side wall of the cell is ruptured, and a little pullulation or process is pushed out, which directly coats itself with cellulose and rapidly enlarges to a considerable diameter, at the same time growing in length until it meets a similar process pushing out from an opposing cell, or has attained as great a length as its laws of development will allow. When two processes meet they become fused together, the end walls are ruptured, and the contents of one cell passing over are received within those of the other, or else the contents of both cells meet within the connecting tube, and there fuse together. This is the more common mode of conjugation, in which two cells of distinct filaments become joined together by a connecting tube. It is evident that, if the filaments are fertile to their fullest extent, there will be as many of these connecting tubes as there are pairs of cells in the filaments, and a ladder-like body will be formed, the original filaments corresponding to the side pieces, the connecting tubes to the rounds. Hence this method of conjugation has received the name of *scalariform.*

"In the so-called *lateral conjugation*, instead of cells of different filaments joining, adjacent cells of one filament unite together to com-

plete the process. The union of the two cells appears to take place in several ways. In accordance with one plan, connecting tubes, pushed out from near the ends of the cells, grow for a short distance nearly at right angles to the long axis of the filaments, and then bend at a right angle to themselves, so as to run parallel to the filament cells. The ends of these processes are, of course, opposed to one another, and coming in contact, fuse together so as to form a continuous tube for the passage of the endochrome. Another method by which neighbouring cells are sometimes connected is by the formation of coadjacent pouch-like enlargements of the opposing ends, and a subsequent fusion of these newly-formed enlargements by the absorption of the end wall between them."

"There is still another method of conjugation, the so-called *genuflexuous*, in which, instead of a connecting tube being formed as the medium of union, two cells of opposing filaments become sharply bent backwards, so that their central portions are strongly thrust forward as obtuse points, which, coming in contact, adhere, and allow of a passage-way between the cells being made by the absorption of their cohering walls."—*Wood's F. Water Algæ*, p. 161.

Hassall says that the conjugation in *Zygnæmaceæ* results in the production of "a dark body, of either an oval or circular form, and enveloped in membrane, which Vaucher, Decaisne, and Jenner regard as the true spores, but which Agardh declares resolve themselves after a time into zoospores, an opinion in which I concur, applying the term sporangia to them." It need scarcely be added that this view is erroneous, the resulting body germinating direct after a period of rest, and termed a zygospore.

The same author makes also another statement, rather vaguely stated, which is not confirmed by experience. "It is curious to remark that the cells in one part of the same filament will part with their contents and remain empty, while in another they will be the recipients of the contents of the cells of another filament." His remarks on agamæsporous *Conjugatæ* will be illustrated under the sub-family *Gonatonemeæ*.

Sub-Family 1. ZYGNEMEÆ.

Cells cylindrical, united in threads. Zygospore undivided,

[redacted]

In certain of the species of this genus the zygospores are produced in the conjugating canal, and in other species in one or other of the conjugating cells. This fact is taken advantage of in the following arrangement :—

A. Zygospores produced in conjugating canal.

* *Sporoderm scrobiculate.*

1. Zygnema pectinatum, *Ag.*

** *Sporoderm even.*

2. Zygnema Ralfsii, *Kutz.*
3. Zygnema parvulum, *Kutz.*

B. Zygospores produced in one or other of the conjugating cells.

* *Sporoderm punctate.*

4. Zygnema cruciatum (*Vauch.*).
5. Zygnema stellinum (*Vauch.*).
6. Zygnema Vaucherii, *Ag.*
7. Zygnema anomalum (*Hass.*).

** *Sporoderm even.*

8. Zygnema leiospermum, *De Bary.*
9. Zygnema insigne, *Kutz.*

A. *Zygospores produced in conjugating canal.*

Zygnema pectinatum. *Ag. Syst. p.* 78.

Sterile cells 1-2 times as long as broad.

Zygospore globose or broadly elliptic, dark olive, scrobiculate, formed in the canal of conjugation.

Size. Cells ·03-·035 mm. diam. (sometimes less), zygospore ·04 mm. diam.

De Bary Conj. p. 77, t. 1, f. 15; 19, t. 8, f. 13. Gray Arr. i. 1296.

Conjugata pectinata, Vauch. Conj. p. 77, t. 7, f. 4.

Conferva bipunctata, Eng. Bot. t. 1610.

Conferva decussata, Dillw. Conf. Syn. p. 5, (?)

Zygogonium pectinatum, Rabh. Alg. iii., 252. Kirsch. Alg. Schl. p. 126.

Tyndaridea conspicua, Hass. Alg. t. 39, f. 1, 2, Ann. Nat. Hist. xii., 187, t. 7, f. 17.

Tyndaridea immersa, Hass. Alg. t. 39, f. 3. Ann. Nat. Hist. xii. 188, t. 7, f. 19.

Tyndaridea decussata, Hass. Alg. t. 39, f. 6. Ann. N. Hist. xii., 188, t. 7, f. 18.

Zygogonium conspicuum, Kutz. Tab. v. t. 12, f. 2.

Zygogonium immersum, Kutz. Tab. v. t. 12, f. 5.

Zygogonium decussatum, Kutz. Tab. v. t. 11, f. 4.

Tyndaridea pectinata, Eng. Fl. v. p. 361; Eng. Bot. ii. t. 2597, Harv. Man. 142 ; Mack. Hib. 231.

Zygnema bipunctatum, Grev. Fl. Ed. 320 ; Fl. Devon. ii. 50.

In still waters.

As noted above, we include here three of Hassall's species of *Tyndaridea.* Kirschner does the same, with the addition of Kutzing's *Z ano-*

malum, which, however, is not the *Tyndaridea anomala* of Ralfs and Hassall, as will be evident hereafter. There does not seem to be even a sufficient difference to justify the maintenance of the different forms as varieties. This is the only British species, as far as at present known, with a scrobiculate zygospore, produced in the channel of conjugation. We have followed De Bary in referring this species to *Zygnema* instead of to *Zygogonium*. It is unnecessary in a work of this kind to discuss the reasons which have induced us in this, and similar cases, to adopt such a course. It may be well to caution the student at once that he will only waste time in the endeavour to determine species from the sterile threads. In the present, for instance, he would soon discover how hopeless it is to attempt to discriminate between the vegetative cells of this and some of its allies, without the knowledge also of the method in which the zygospore is formed, and its character when developed.

Plate XXIX. fig. 1. *a*, portion of sterile thread × 400; *b*, threads in conjugation × 200; *c*, zygospore × 400.

Zygnema Ralfsii. (*Kutz.*) *De Bary Conj. p.* 77.

Sterile cells $2\frac{1}{2}$ to 3 (rarely 4) times as long as broad.

Zygospore compressed ellipsoid, twice as long as broad, produced in the inflated conjunctive canal. Sporoderm even.

SIZE. Cells ·016-·017 × ·02 mm. Zygospore ·025 × ·015 mm.

Rabh. Alg. Eur. iii. p. 252.

Zygogonium Ralfsii, Kutz. Tab. v. t. 11, f. 2. Kirsch. Alg. Schl. p. 127.

Tyndaridea Ralfsii, Hassall Alg. p. 165, t. 39, fig. 4, 5.

Ann. Nat. Hist. xii. p. 188, t. 7, f. 20. Jenner Fl. Tunb. Wells. p. 182.

In pools and streams.

This is the only other British species of *Zygnema* in which the zygospore is produced in the channel, except the succeeding one, which is at best doubtful. It appears to be uncommon, at least in conjugation. [redacted]

the whole evidence upon which this species is inserted. The figure in the "Gleanings," as represented, in part, on our plate 29 (fig. 3c), is so manifestly insufficient, without measurements, that the species is introduced with some hesitation. The rest of our figures, and the description, are derived from Continental sources, and represent Kutzing's species.

Berkeley says of the plant he has figured:—"The filaments are quite unattached, and float in a rather dull green mass at the top of the water, which (at least in a state of fructification) is but little mucous, adhering imperfectly to paper in drying. But as the plant has only been once met with, and it is well known that other species of *Zygnema* are much less mucous in a state of fructification, it is uncertain whether this is peculiar at all to the species. Articulations 4 to 6 times as long as broad, at first filled with a yellowish green sporaceous mass, without any marked pellucid border, with a single row in the centre of from 5 to 7 larger granules. The mass at length contracts, and the row of granules is no longer visible. Short tubes are thrown out from the centre of the joints, by which the filaments are at length connected into a more or less intricate mass, and in the tubes a globular seed is formed, which swells them, and is furnished with a pellucid border. In general the sporaceous matter of only one articulation passes into the tube to form the seed; nor in such case does the joint, of which the contents still appear unaltered, throw out another tube. Found at Glapthorn, Northamptonshire, in the spring of 1826, in watery spots of an exposed, ill-drained field."

Plate XXIX. fig. 3. *a*, portion of sterile thread × 400; *b*, threads in conjugation × 200; *c*, conjugating cells and zygospores of *Zygnema ordinarium*, after Berkeley, magnification unknown.

B. Zygospores produced in one or other of the conjugating cells.

Zygnema cruciatum. (*Vauch.*)

Sterile cells equal or twice as long as broad.

Zygospore sphærical, formed in one or other of two conjoined cells. Membrane brown and scrobiculate.

Size. Cells ·028 mm. broad. Zygospore ·04 mm. diam.

Cleve Mon. Zygn. p. 29, t. 9, f. 1-3. Kirsch. Alg. Schl. p. 126. Kutz. Tab. Phy. v. t. 17, f. 4.

Conjugata cruciata, Vauch. Hist. Conf. p. 76, t. 7, f. 2.

Tyndaridea cruciata, Hass. Alg. 160, t. 38, f. 1. Eng. Bot. Ed. 2, t. 2512 B. Eng. Fl. v. p. 361. Mack. Hib. 231.

Conferva bipunctata, Dillw. Conf. t. 2. Hook Fl. Scot. ii, 81.

Zygnema bipunctatum, Johnst. Fl. Berw. ii, 256. Gray Arr. i, 296.

Zygnema Dillwyni, Kutz. Tab. Phy. v. t. 17, f.

In ditches, pools, &c.

The form figured by Dillwyn is more slender than the typical form and is considered by some as a distinct variety.

There is, perhaps, some difficulty in determining the exact limits of the three species *L. cruciatum*, *L. stellinum*, and *L. Vaucherii*, unless by merging the latter two in one, and accepting *Z. cruciatum* as possessing globose zygospores, whilst the other species has oval, or somewhat elongated zygospores.

Plate XXX. fig. 1. *a*, portion of sterile thread × 400; *b*, conjugating threads with zygospores × 200; *c*, mature zygospore × 400.

Zygnema stellinum. (*Vauch.*) *Kutz. Tab. V. t.* 17, *f.* 2.

Sterile cells $1\frac{1}{2}$ to 3 times longer than broad.

Zygospore broadly ovoid, formed in one or other of the conjoined cells. Membrane brown, scrobiculate.

Sporiferous cells commonly longer than the zygospore.

SIZE. Cells ·022 mm. Zygospore ·04 × ·03 mm.

De Bary Conj. p. 78. Cleve Mon. Zyg. p. 28, t. 8, f. 9-11. Rabh. Alg. Eur. iii, 249.

Conjugata stellina, Vauch. Conf. p. 75, t. 7, f. 1.

Thwaitesia Duriæi, Mont. Fl. Alg. t. 15, f. 1.

Tyndaridea stellina, Jenner Fl. Tunb. Wells. p. 182.

In pools and ditches.

Kirschner unites this species and the next, for which he appears to have great justification. We scarcely see how they can be maintained as distinct if the broad view of *Zygnema Vaucherii* which we have adopted is tenable.

No definite period can be fixed for the production of the zygospores, not only in this species, but in the majority of the *Zygnemaceæ*. We have observed them in June, or earlier, some as soon as April, and as late as September. Hassall says "the species may be found in a state of conjugation during the entire of the spring, summer, and autumnal months; they are chiefly met with, however, in this state in the spring." Cleve has attached dates to the species enumerated by him, but as these do not correspond with the periods at which we have found them in this country, these dates are not quoted lest they should prove misleading rather than useful.

Plate XXX. fig. 2. *a*, portion of sterile thread × 400; *b*, conjugating threads and zygospores × 400.

Zygnema Vaucherii. *Ag. Syst. Alg. p.* 77.

Sterile cells $2\frac{1}{2}$ or 3 to 5 times as long as broad.

[redacted]

var. c. **stagnale.** *Kirsch.*

Sterile cells ·01 mm., 3 to 4 times as long.

Tyndaridea stagnalis, Hass. Alg. 162, t. 38, f. 9.

Tyndaridea stagnicola, Hass. Ann. N. Hist. x. (1842) p. 42. Jenner Fl. Tunb. Wells, p. 182.

It will be seen from the above that this is a variable species, of which two of the three varieties are British. These are by no means uncommon, often mixed with other filamentous algæ, and can scarcely be confounded with anything else, even when sterile.

Plate XXX. fig. 3. *a*, portion of sterile thread × 400; *b*, portion of fertile thread with zygospores × 400. Fig. 4, var. *subtile*. *a*, portion of sterile threads × 400; *b*, conjugating threads and zygospores × 400. Fig. 5, var. *stagnale*. *a*, portions of sterile threads × 400; *b*, fertile cells with zygospores × 400.

Zygnema anomalum. (*Hass.*)

Sterile cells equal, or nearly twice as long as broad; cytioderm thick, lamellose.

Zygospore globose, olivaceous (sporoderm distinctly punctate ?).

Size. Cells ·025 mm. diam., with mucous sheath about double; zygospore ·026 mm. diam.

Tyndaridea lutescens, Hass. Alg. t. 38, f. 4. Dickie Bot. Guide 296.

Tyndaridea cruciata, Harv. Man. p. 141.

Tyndaridea abbreviata, Hass. Ann. Nat. Hist. x. (1842) p. 43.

Tyndaridea anomala, Hass. Alg. t. 38, f. 2-3. Jenner Fl. Tunb. Wells, 182. Ralfs, Eng. Bot. Supp. t. 2899.

In boggy pools.

The British species is the *Tyndaridea anomala* of Hassall and Ralfs, and not the *Zygnema anomalum* of Continental botanists, which species has the zygospore produced in the conjugating canal. The following is the original description published by Ralfs in the supplement to "English Botany":—

"It forms large, dark green masses in shallow pools on heaths. The filaments are stout; under the microscope each is found to be enclosed in a hyaline sheath, which extends on each side about half the breadth of the coloured portion, and is always more or less waved or scolloped. At first it is nearly even, but it gradually becomes more and more irregular, and the conjugating specimens are almost denuded. The joints of the filament are usually about equal in length and breadth, but sometimes twice as long as broad. The endochrome is blackish green, and at first quadrate, when it completely fills the joint, but its division into two portions gradually becomes apparent until two stellæ, but less distinct than those in the other species, are at last developed, when conjugation takes place in the usual manner. The spores, which are globular, are contained in the joints of one of the connected filaments. Not unfrequently the tubular processes are themselves converted into cells containing endochrome.

"In its early state this plant is so different in appearance from the other species, that at first sight its proper situation is scarcely appa-

rent. Indeed, having sent specimens to several celebrated algologists, they hesitated to admit it into *Tyndaridea*, until Mr. Hassall, who also at first strongly doubted whether it belonged to the *Conjugatæ*, fortunately gathered fertile specimens. Such we ourselves found shortly afterwards, and we have since repeatedly met with them; the appearance of the plant in conjugation, however, is so altered that its identity can only be determined by tracing it through all its changes.

"In its usual state the sheath is very conspicuous, and the dense endochrome so fills the cells that the plant looks like a *Conferva*, the continuity being interrupted merely at the dissepiments. When about to conjugate the sheath has nearly or altogether disappeared, and the endochrome is collected into two stellæ, leaving the rest of the cell colourless."—*Ralfs*.

Hassall also found and examined the plant, and figured it with zygospores in the cells of the filaments, whereas the Continental species, since the figure by Kutzing, is always described as having the zygospore in the canal of conjugation. There cannot, therefore, be the slightest doubt that the species found by Hassall and Ralfs is quite distinct from that known to Kutzing, Rabenhorst, and De Bary. Priority certainly is in favour of Hassall's name, and it is the Continental species which must give way, and yield up a name, acquired in error, to its rightful claimant. Our figures are based on the sketches and drawings by Ralfs, with whom we have been in communication on this question. It is absurd to suppose that Ralfs and Hassall were both deceived, as well as Mr. Jenner (an admirable observer), to whom the species was undoubtedly known, and finally Mr. Salter in preparing the drawings from the specimens for the "English Botany." Unfortunately we could find no fruit in the specimens which we possess, collected by Ralfs forty years ago, nor could we obtain specimens in conjugation from Cornwall during the past spring.

Plate XXXI. fig. 1. *a, b,* portions of sterile threads × 400; *c,* fertile cells with zygospores × 400, after Ralfs; *d,* conjugating cells × 400.

Zygnema leiospermum. *De Bary. Rabh. Algæ Exs. No.* 638.

[redacted]

Zygnema insigne. *Kutz. Tab.* v. *t.* 17, *f.* 1.

Sterile cells equal, or twice as long as broad.

Copulation scalariform or lateral; zygospore globose or slightly oval; membrane brown, even.

SIZE. Cells ·026-·03 mm. diam.; zygospore about ·026 × ·032 mm., or globose about ·03 mm. diam.

De Bary Conj. p. 78, t. 8, f. 14-16. Rabh. Alg. iii. 249. Kutz. Tab. v. t. 17, f. 1. Kirsch. Alg. Schl. p. 125.

Tyndaridea insignis, Hass. Alg. p. 163, t. 38, f. 6, 7. Jenner Fl. Tunb. Wells 182.

Zygnema tenue, Rabh. Exs. No. 674.

In streams and ditches.

The cells of this species at the time of conjugation are apt to become much distorted, inflated sometimes on one side, sometimes on the other, and even to conjugate in the manner represented by De Bary, and copied on our plate.

Plate XXXI. fig. 3. *a*, sterile cells × 400; *b*, fertile cells with zygospores × 200; *c*, fertile cells, with longitudinal conjugation, × 200, after De Bary; *d*, zygospore × 400.

GENUS 45. **SPIROGYRA.** *Link.* (1820.)

Cells with one to several parietal chlorophyll bands, usually spirally winding to the right. Copulation ladder-like (*Spirogyra*) or lateral (*Rhynchonema*). Zygospores always within the wall of one of the united cells. Copulating cells similar to the sterile ones, or swollen out.

This genus, as now accepted, includes two genera as recognised by Kutzing, *Spirogyra* and *Rhynchonema*. In the former the conjugation was scalariform, and in the latter it was lateral. It is now found that in many species, probably in all, both kinds of conjugation take place, according to circumstances. The same filament, which in some portion of its length conjugates with a neighbouring filament, has also been observed conjugating laterally between two of its own cells. The genus *Rhynchonema* therefore has thus been proved to represent only one of the modes of conjugation of the same plant, which under other conditions conjugates with a neighbouring filament.

In past times too great importance was attached to the breadth and length of the cells in the sterile filaments, and also to the character of the spiral bands, features which are now known to be too variable to be relied upon, the most important and reliable characters being derived from the zygospore; hence only specimens in fructification can be accurately determined.

The most recent work on the species of Western Europe is a Monograph of *Spirogyra*, as represented in France, by Mons. Paul Petit. (Paris, 1880.) See also Professor Cleve's "Monograph of the Zygnemaceæ."

The following is a tabular arrangement of the British species :—

Sec. 1. Cells *not* replicate at the ends.

A. *Chlorophyll bands numerous (rarely two).*

* Spores ovoid or elliptic.

† Membrane smooth.

1. crassa, *Ktz.*
2. jugalis, *Dill.*
3. nitida, *Lk.*

†† Membrane punctate.

None.

** Spores orbicular.

† Membrane smooth.

4. orthospira, *Nag.*

†† Membrane punctate.

5. orbicularis, *Hass.*
6. bellis, *Hass.*

B. *Chlorophyll bands single or double (rarely ternate).*

* Spore membrane smooth.

7. porticalis, *Vauch.*

var. a. quinina.

Chlorophyll bands usually single.

var. β. decimina.

Chlorophyll bands usually binate, rarely ternate.

var. ς. rivularis, Hass.

Chlorophyll bands usually three.

** Spore membrane punctate.

None.

N.B.—*Spirogyra elongata*, Berk. Glean., p. 33, tab. 12, f. 3 (Rabh. Alg. iii. 241), would follow here but that the fruit is unknown, and hence it is uncertain.

C. *Chlorophyll bands single.*

* Spore membrane smooth.

[redacted]

The English student may also consult with advantage a memoir "on the germination of the resting spores in Spirogyra," by Dr. Pringsheim, translated in the Annals of Natural History, 2nd ser., Vol. xi. (1853), p. 210. "On the Structure and Division of the Vegetable Cell," by J. M. Macfarlane, in Transactions of the Botanical Society of Edinburgh, Vol. xiv. (1881). Pringsheim's Researches on Chlorophyll, translated by Professor Bayley Balfour, in Quarterly Journal of Microscopical Science, Vol. xxii., new series (1882). Darwin "On the Action of Carbonate of Ammonia on Chlorophyll Bodies," in Journal of the Linnean Society, Vol. xix. (1882).

SECTION 1. Cells not replicate at the ends.

A. *Chlorophyll bands numerous (rarely two).*

Spirogyra crassa. *Kutz.*

Sterile cells with the extremities truncate, equal or twice as long as broad. Chlorophyll bands four or more, making ½-1½ turns.

Zygospores broadly and obtusely oval, membrane even.

Sporiferous cells persistent, not swollen.

SIZE. Cells ·12-·15 mm. diam. (*Rabh.*), ·15 mm. diam. (*Petit*), zygospore ·14-·15 diam. (*Petit*), ·13 × ·12 ; ·14 × ·12 ; ·16 × ·12 mm. (*M.C.C.*).

Zygnema serratum, Hass. Alg. t. 18, f. 1.

Spirogyra crassa, Kutz. Tab. v. t. 28, f. 2 ; Kutz. Phy. Gen. t. 14, f. 4 ; Kirsch. Alg. Schl. p. 119 ; Petit Spirogyra p. 32, t. 12, f. 3, 4.

Spirogyra Heeriana, Kutz. Tab. v. t. 28, f. 3.

In ponds, &c. Fruiting in summer.

Hassall says of his *Z. serratum* that the "filaments are of nearly the same diameter as those of *Z. orbiculare*, but less mucous, from which species it may readily be distinguished by the fewer number and serrated appearance of the spores, the larger size of the granules, and the form of the sporangia, which in *Z. orbiculare* are nearly sphærical, and compressed, while in *Z. serratum* they are broadly ovate."

The sterile cells have a greater diameter than any other British species, whilst their length varies from about half a diameter to two diameters. The zygospore is comparatively broader than in *S. jugalis*, and slightly flattened, so that when seen in certain positions it appears to be narrower than it is, and more resembling that of *S. jugalis*.

On plate 32, figs. 1 and 2, the nucleus is represented in the centre of the cells. Pringsheim has recently remarked, as a fact hitherto unrecognised, that "the threads of the protoplasm extending outwards from the central plasma mass in each cell, do not, as was supposed, end in the general protoplasmic lining of the cell wall, but each passes directly or by its branches to the internal surface of a chlorophyll band, and there dilates in a trumpet-like manner, and grasps, as it were, an amylum body."—*Researches on Chlorophyll*, p. 81.

Plate XXXII. fig. 1. *a*, sterile cells × 200; *b*, fertile cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospore × 200; *d*, outline of zygospore × 400.

Spirogyra jugalis. (*Dill.*)

Sterile cells with the ends truncate, and commonly equal, or double the length of the diameter. Chlorophyll bands 4 to 5, making 1 to 2 turns.

Zygospore elliptical, membrane even.

Sporiferous cells not swollen.

SIZE. Sterile cells ·09-·1 mm. diam. (*Petit*), ·14 mm. diam. (*Cleve*), ·075-·1 mm. diam. (*Rabh.*), ·087-·11 mm. diam. (*Kirsch.*). Zygospores ·14 × ·1-·12 mm. (*Cleve*), ·15 × ·1 mm. (*Petit*), ·13-·14 × ·085-·09 mm. (*M.C.C.*).

Conferva jugalis, Dillw. Brit Conf. t. 5.

Spirogyra jugalis, Kutz. Tab. v. t. 27, f. 2; Petit Spirogyra p. 29, t. 11, f. 3, 4; Rabh. Alg. Eur. iii. 245.

Spirogyra setiformis, Petit Spirogyra, p. 29, t. 11, f. 1, 2 (not Kutz., nor Rabh. Alg. Eur.); Rabh. Exs. 2292; Cleve Mon. Zyg. p. 15 (partly), t. 1, f. 1-3.

In clear ponds, &c. Fruiting at Midsummer.

The British specimens which we refer to this species have the sterile cells from ·12 to ·14 mm. broad, and about two diameters long. The zygospore is from ·13 to ·14 mm. long and ·085 mm. broad. In other specimens, from the Continent, we have found the zygospores from ·11 to ·13 mm. long and ·095 mm. broad. M. Petit recognises two species, which he calls respectively *S. jugalis* and *S. setiformis*, differing so little from each other that it seems scarcely possible to distinguish them except in extreme cases. To the latter he refers *Z. interruptum* of Hassall, but, without the fruit, which Hassall never found, it is difficult to affirm what it might be. It is quite as probable that it was *S. orbicularis* as anything else.

Plate XXXII. fig. 2. *a*, sterile cells × 200; *b*, fertile cells with zygospores × 200; *c*, outline of zygospore × 400.

Spirogyra nitida. (*Dillw.*) *Link Handbk.* III., 262.

[redacted]

Spirogyra nitida, Kutz. Tab. Phy. v. t. 27, f. 1. Kirsch. Alg. Schl. p. 123. Petit Spirogyra p. 28, t. 10, f. 6 to 10.

Conferva nitidum, Dill. Conf. t. 4, f. C. Eng. Bot. ed. i. t. 2337. Jenner Fl. Tunb. Wells 178. Gray Arr. i. 298.

Zygnema rostratum, Hass. Alg. t. 33, f. 1.

In ponds, &c.

Very little requires to be said of this species, which is the most common one with thick filaments in Britain. It is most probable that Hassall's *Zygnema rostratum* is the same, conjugating longitudinally, for he says that the filaments are somewhat larger than those of his *Zygnema nitidum*, but that he had only seen it once. The form of zygospore figured by him is that of the present species, and *not* of *Spirogyra bellis*, to which the *Rhynchonema rostrata* of Kutzing is referred by Cleve.

Cleve proposed to substitute the name of *Spirogyra princeps*, Vauch., for the universally known *Spirogyra nitida*, a change with which we by no means sympathise, because, after all, it is only a matter of opinion, and not of demonstration, whether this is really the *Conjugata princeps* of Vaucher, and there should be a good and substantial reasons for superseding a specific name so long recognised as *Spirogyra nitida*.

Plate XXXIII. fig. 1. *a, b*, sterile cells × 200; *c*, conjugating cells with zygospores × 200; *d*, outline of zygospore × 400.

Spirogyra orthospira. *Näg. in Kutz. Spec. p.* 441.

Sterile cells with the extremities truncate, and from 2½ to 4 to 10 times as long as broad; chlorophyll bands 3 to 4 to 5 (rarely 7), sometimes erect, sometimes forming a very lax spiral.

Spores orbicular, flattened, membrane even.

Sporiferous cells scarcely swollen, 2½ to 4 times as long as the diameter.

Size. Cells ·05-·065 mm. diam.; zygospore ·07 mm. diam., ·048 mm. thick.

Spirogyra orthospira, Archer in Quart. Journ. Micr. Sci., 1870. Petit Spirogyra p. 30, t. 10, f. 4, 5.

Spirogyra majuscula, Kutz. Tab. Phy. v. t. 26, f. 1. Rabh. Alg. iii. 244.

In pools. Fruiting in autumn.

This is a recently discovered species in the British Islands, and has hitherto only been recognised by Mr. Archer in Ireland.

Plate XXXIII. fig. 2. *a, a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, front and side views of zygospore × 400.

Spirogyra orbicularis. *Hassall Alg. t.* 19.

Sterile cells with the ends truncate, about equal in length to breadth; chlorophyll bands 5 to 7, making ½ to 1 turn.

Zygospores orbicular, flattened, membrane punctate.

Sporiferous cells not inflated.

SIZE. Cells ·11-·14 mm. diam.; zygospores ·1 mm. diam. Narrow diameter ·08 mm.

Petit Spirogyra p. 31, t. 12, f. 1, 2. Kutz. Tab. v. t. 27, f. 3. Kirsch. Alg. Schl. p. 118. Rabh. Alg. Eur. iii. 245.

Zygnema orbiculare, Hass. Alg. p. 138, t. 19. Jenner Fl. Tunb. Wells 178.

Zygnema alternatum, Hass. Alg. 139, t. 20.

Zygnema interruptum, Hass. Alg. 140, t. 21. Ann. Nat. Hist. 1843, p. 432.

Zygnema maximum, Hass. Ann. Nat. Hist. x. (1842), p. 36.

Spirogyra alternata, Kutz. Spec. 442. Rabh. Alg. iii. 248.

Spirogyra setiformis, Kutz. Tab. v. t. 28, fig. 1 (not Petit). Rabh. Alg. iii. 246. Cleve Mon. Zyg. p. 15 (in part).

In ponds, &c. Fruiting in autumn.

There is nothing inconsistent in Cleve's suggestion that Hassall's three plates 19, 20, and 21 all belong to the same species. No reliance can be placed on the width of the chlorophyll bands, nor the little difference in the breadth of the cells. Of course the disturbance in the bands of the conjugated cells is due to the conjugation. When this species is really in fruit there can be no difficulty in its determination, and, without fruit, it is folly to waste time in attempting to guess at the relationship of any species.

Hassall says that " it is found in ponds and dykes whose waters are deep and permanent, and it does not conjugate until near the end of summer." " Cells when in a state of conjugation, a little longer than broad, prior to which, however, they are frequently not half so long as broad; winding round the interior of these are about eight spiral threads, the granules in them being small."

Plate XXXIV. fig. 1. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, outline of zygospore × 400.

Spirogyra bellis. *Hassall.*

Zygnema neglectum, Hass. Alg. t. 23, f. 1 (not Petit). Hass. Ann. Nat. Hist. x. 37. Jenner Fl. Tunb. Wells 178.

In ponds. Fruiting in August.

This species is rather a characteristic one, of which it appears to us that *Zygnema neglectum*, Hass., is only a form with three chlorophyll bands. If the two species of Hassall are drawn to the same scale, it is difficult to indicate any specific difference. The *Rhynchonema rostratum* of Kutzing is referred by Cleve to this species, but the *Zygnema rostratum* of Hassall appears to be different, with thicker filaments and much longer zygospores, and is rather referable to *Spirogyra nitida*. The *Spirogyra neglecta* of Petit cannot be the *Zygnema neglectum* of Hassall.

This species is thus described by Hassall:—" Filaments about a foot in length, with truncate extremities; of considerable though rather less diameter than those of *S. nitida*, mucous, glossy, and of a deep and beautiful green colour; investing membrane of the cells very evident and transparent. Cells in the young filaments scarcely so long as broad, but their length exceeds their breadth in those which have conjugated; round the interior of the cells five or six loose spiral tubes may be faintly discerned; these contain the reproductive globules (*sic*), which are large and distinct, with a dark central nucleus. Sporangia oval sometimes almost circular and flattened, lying in inflated cells, the cavity of which they do not fill."

Plate XXXIV. fig. 2. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospore × 200; *d*, outline of zygospore × 400.

B. *Chlorophyll bands single or double (rarely ternate).*

Spirogyra porticalis. *Vauch.*

Sterile cells with the extremities truncate, 2 to 4 times longer than the diameter; chlorophyll bands single, or binate, rarely ternate.

Spores obtuse, ovoid, $1\frac{1}{2}$ times longer than the diameter, membrane even, chestnut colour.

Sporiferous cells equal to the length of the spore, or twice as long, more or less turgid.

Size. Cells ·032-·05 mm. diam. Zygospore ·08 × ·048-·05 mm.

Cleve Monog. Zygn. p. 22, t. 5, f. 8 to 13.

Conjugata porticalis, Vauch. Conf. p. 66, t. 5, f. 1.

In ditches, &c. Fruiting in spring.

var. a. **quinina.**

Chlorophyll bands usually single.

Size. Cells ·035-·045 mm., about twice as long.

Zygnema quininum, Hass. Alg. t. 28, f. 1, 2. Harv. Man. p. 143. Landsborough Brit. Seaweeds p. 362. Eng. Fl. v. 362. Eng. Bot. Ed. ii. p. 175. Harv. Man. 143. Johnst. Fl. Berw. ii. 256. Grev. Fl. Ed. 320. Mac. Fl. Hib. 231. Fl. Devon ii. 50. Hook. Fl. Scot. ii. 80. Dickie Bot. Guide, 296.

Spirogyra quinina, Kutz. Tab. v. t. 22, f. 2.
Spirogyra porticalis, Petit Spirogyra, p. 21, t. 5, f. 8-12.
Conferva spiralis, Dillw. Conf. t. 3. Eng. Bot. Ed. i. t. 1656.
Zygnema spiralis, Eng. Bot. Ed. ii. t. 2561.
Conjugata quinina, Gray Arr. i. 297.

var. β. **decimina.**

Chlorophyll bands usually 2, sometimes 3.

Size. Cells ·034-·04 mm., 2 to 4 times as long.

Zygnema deciminum, Hass. Alg. t. 23, f. 3, 4. Harv. Man. p. 143. Johnst. Fl. Berw. ii. 255. Mack. Fl. Hib. 2, 31. Fl. Devon ii. 50. Jenner Fl. Tunb. Wells 178. Grev. Fl. Edin. 320. Eng. Fl. v. 362.

Spirogyra decimina, Kutz. tab. v. t. 23, f. 3, 24, f. 1. Petit Spirogyra p. 25, t. 8, f. 1-3. Rabh. Alg. iii. p. 242.

Spirogyra flavicans, Kutz. tab. v. t. 23, f. 3.
Spirogyra laxa, Kutz. Tab. v. t. 23, f. 3.
Spirogyra major, Kutz. Tab. v. t. 24, f. 2.
Conferva jugalis, Dillw. Conf. t. 5.
Conferva inflata, Eng. Bot. Ed. i. t. 2376.

Zygnema inflatum, Eng. Bot. Ed. ii. t. 2510. Hook. Fl. Scot. ii. 80.

Conjugata inflata, Gray Arr. i. 297. (?)
Conjugata decimina, Gray Arr. i. 299.

var. γ. **rivularis.** *Hass.*

Size. Cells ·032-·036 mm., 5 to 10 times as long.

Zygnema rivulare, Hass. Alg. 144, t. 27, f. 1, 2. Annals Nat. Hist. x. 38.

C. *Chlorophyll bands single.*

Spirogyra condensata. *Vauch.*

Sterile cells with the extremities truncate, and commonly 1 to $3\frac{1}{2}$ longer than the diameter. Chlorophyll bands single, rarely two, making $1\frac{1}{2}$ to 2 turns of the spiral.

Spores broadly obtuse, ovoid, or subspherical, membrane even, chestnut colour.

Sporiferous cells turgid, and usually shorter than the spores.

SIZE. Cells ·04 mm. diam., zygospores ·035-·04 mm. diam.

Cleve Monog. Zygn. p. 21, t. v. f. 1-7.

Conjugata condensata, Vauch. Conf. t. 5, f. 2. Gray Arr. i. 298.

Zygnema varians, Hass. Alg. t. 29, f. 3 and 4. Jenner Fl. Tunb. Wells, 180.

Zygnema Woodsii, Hass. Alg. t. 33, f. 2. Jenner Fl. Tunb. Wells, 180.

Spirogyra torulosa, Kutz. Tab. v. t. 20, f. 2.

Spirogyra nodosa, Kutz. Tab. v. t. 20, f. 3.

Spirogyra arcta, Kutz. Tab. v. t. 21, f. 2.

Spirogyra condensata, Kutz. Tab. v. t. 22, f. 3. Petit Spirogyra, p. 22, t. 9, fig. 6-8.

Rhynchonema Woodsii, Kutz. Tab. v. t. 34, f. 2 (not of Nord. and Wittr. Exs., No. 789).

Spirogyra Flechsigii, Rabh. Hedw. i. p. 46.

Zygnema quininum, var. Hass. Ann. Nat. Hist. x. (1842) 35.

Spirogyra ulotrichoides, Kutz. Tab. v. t. 21, f. 3.

Spirogyra varians, Kutz. Sp. Alg. p. 439. Petit Spirogyra p. 49, t. 4, f. 1-8.

Spirogyra inflata, Kutz. Tab. v. t. 21, f. 1-8.

In pools. Fruiting in spring.

From the number of synonyms quoted above, it may be inferred that this is a variable species. All the forms seem to be included by Petit under his *Spirogyra condensata* and *S. varians*.

Hassall thus alludes to a peculiar nodoluse growth of some of the forms:—" When a number of cells unite in regular order with those of a neighbouring filament, no inflation of any of these occurs; but it frequently happens that several adjoining cells of a filament for some reason or other do not unite, although the remaining ones in that filament do, in which case those which have not yoked themselves swell up, assuming a monoliform appearance, and at the same time frequently emit blind and irregular processes or prolongations, by which the cells manifest the strong tendency which they have to conjoin themselves, but which some cause, not evident, would appear to have frustrated. In some specimens the number of inflated cells and blind processes is but small, while in others the elongated cells are more numerous than those which have united in the ordinary manner." A similar circumstance may sometimes be observed in *S. longata*, especially in the short-celled forms.

Plate XXXVI. fig. 1. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, sterile cells of inflated form × 200; *d*, conjugating cells with zygospores × 200; *e*, *f*, *g*, outlines of zygospores × 400.

Spirogyra longata. *Vauch.*

Sterile cells with the ends truncate, 3 to 8 times as long as broad, chlorophyll bands single or rarely two, making $1\frac{1}{2}$ to 6 turns of a spiral.

Spores $1\frac{1}{2}$ to 2 times as long as broad, membrane even, chestnut colour.

Sporiferous cells swollen and usually longer than the spore.

SIZE. Cells ·024-·03 mm. diam. Zygospore ·04-·07 × ·03 mm.

Cleve Monog. Zygn. p. 20, t. 3, f. 8-10; t. 4, f. 1-7; t. 10, f. 11-13.

Conjugata longata, Vauch. Conf. p. 71, t. 6, f. 1.

In pools and ditches.

var. a. **communis.**

Sterile cells 3 to 8 times as long as broad.

Spirogyra longata, Kutz. Tab. v. t. 20, f. 1. Rabh. iii. 238. Petit Spirogyra t. 5, f. 4, 5.

Zygnema commune, Hass. Alg. t. 28, f. 5, 6. Ann. Nat. Hist. x. (1842) p. 39. Jenner Fl. Tunb. Wells, 180.

Zygnema æstivum, Hass. Alg. t. 28, f. 3, 4. Ann. Nat. Hist. xi. (1843), p. 433. Jenner Fl. Tunb. Wells, 180.

Zygnema angulare, Hass. Alg. t. 34, f. 1, 2. Jenner Fl. Tunb. Wells, 180.

Zygnema angulatum, Hass. Ann. Nat. Hist. x. (1842) p. 41.

Zygnema reversum, Hass. Alg. t. 33, f. 3.

Zygnema alternatum, Hass. Alg. p. 154.

Zygnema mirabile, Hass. Alg. t. 35, f. 1-3.

[redacted]

Spirogyra turpis, Kutz. Tab. v. t. 19, f. 2. Rab. iii. 238.

Spirogyra catæneformis, Kutz. Tab. v. t. 19, f. 1. Rab. iii. 238. Petit Spirogyra t. 3, f. 9-12.

Rhynchonema abbreviatum, Kutz. Rab. iii. 248.

We venture to differ from our friend Mons. Petit in uniting four of his species. In fact, if four species are to be accepted, we see no logical grounds for refusing to accept a dozen, because of the excessive variability in the sterile cells.

Plate XXXVI. fig. 2. *a, b*, sterile cells × 200; *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospore × 200; *e*, fertile cells of *mirabilis* form with zygospores × 200; *f*, conjugating cells of *catenæformis* form with zygospores × 200; *g, h, i, k*, outline zygospores × 400.

Spirogyra flavescens. (*Hass.*) *Cleve.*

Sterile cells with the ends truncate, 2½ to 5 times longer than broad, chlorophyll bands single.

Spores attenuated, twice as long as broad, membrane even, chestnut colour.

Sporiferous cells swollen, and usually longer than the spores.

SIZE. Cells ·02 mm. diam. Zygospore ·05 × ·024 mm.

Cleve Monog. Zygn. p. 19, t. 3, f. 6, 7.

Boggy pools on heaths, &c.

form a. **gracilis.**

Zygospore about ·03 mm. diam.

Zygnema gracile, Hass. Alg. t. 30, f. 5, 6.

Spirogyra gracilis, Kutz. Tab. v. t. 18, f. 5. Petit Spirogyra p. 15, t. 3, f. 7, 8.

Zygnema malleolum, Hass. Alg. t. 34, f. 5.

Rhynchonema malleolus, Kutz. Tab. v. t. 33, f. 3.

form b. **flavescens.**

Zygospore about ·02 mm. diam.

Zygnema flavescens, Hass. Alg. t. 30, f. 9, 10. Jenner Fl. Tunb. Wells, 180.

Spirogyra flavescens, Kutz. Tab. v. t. 18, f. 4. Petit Spirogyra p. 15, t. 3, f. 5, 6.

Zygnema affine, Hass. Alg. t. 34, f. 6.

Spirogyra affinis, Petit Spirogyra, p. 18, t. 3, f. 12, 13.

Rhynchonema affine, Kutz. Tab. v. t. 33, f. 2.

form c. **parva.**

Zygospore about ·01 mm. diam.

Zygnema parvum, Hass. Alg. t. 30, f, 7, 8. Ann. Nat. Hist. x. (1842) p. 41. Jenner Fl. Tunb. Wells, 180.

Spirogyra parva, Kutz. Tab. v. t. 18, f. 3.

This species includes five of Hassall's species of *Zygnema*, which subsequently were relegated by Kutzing, three to *Spirogyra* and two to *Rhynchonema*. The *Zygnema flavescens, parvum*, and *gracile*, are sepa-

rated by distinctions so minute and variable, that they cannot be maintained as other than varieties, and *Zygnema malleolum* and *Z. affine* were at the time suspected of being varieties the one of the other.

***Plate XXXVII. fig.* 1. Variety *gracilis*. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospores × 200; *d*, outline zygospores × 400. Fig. 2, variety *flavescens*. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospores × 200; *e*, outline zygospores × 400. Fig. 3, variety *parva*. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, outline zygospores × 400.**

SECTION 2. Cells replicate at the ends.

A. *Chlorophyll bands usually two or more.*

Spirogyra insignis. *Hass.*

Sterile cells with the extremities replicate, $4\frac{1}{2}$ to 5 (rarely 6) times as long as broad, chlorophyll bands 2 to 3, lax, with 1 to 2 turns of spiral, or nearly erect.

Spores ovate-elliptic, twice as long as broad, membrane even.

Sporiferous cells slightly swollen.

SIZE. Sterile cells ·03-·035 mm. Zygospore ·04-·05 mm., 2 to 3 times as long.

Rabh. Alg. Eur. iii. 243.

Zygnema insigne, Hass. Alg. 440, t. 103, f. 1, 2.

Zygnema Hassallii, Hass. Alg. 157, t. 36, f. 4, 5. Jenner Fl. Tunb. Wells, 182.

Spirogyra insignis, Kutz. Tab. v. t. 31, f. 4. Sur. Obs. t. 1, f. a.

Rhynchonema Hassallii, Kutz. Tab. v. t. 32, f. 7.

Spirogyra Braunii, Rabh. Alg. Ex. No. 1310, 1395.

Spirogyra Hantschii, Rabh. Alg. Ex. No. 1291.

Spirogyra Theobaldii, Kutz. Tab. v. t. 31, f. 2.

[redacted]

form α **major.**

Diameter of threads ·05 mm. Bands 2 to 3.

form β **minor.**

Diameter of threads ·032 mm. Band single.

SIZE. Zygospore ·078-·096 × ·045 mm.

Archer in Quart. Journ. Micr. Sci., 1873, xiii. p. 436. Petit Spirogyra p. 11, t. 2, fig. 11-13.

Spirogyra protecta, Wood. F. W. Alg. t. 14, f. 3.

In bogs and moor pools.

Plate XXXVIII. fig. 2. *a,* sterile cells × 200; *b, c,* conjugating cells with zygospores × 200; *d,* outline zygospore × 400.

B. *Chlorophyll bands single.*

Spirogyra quadrata. (*Hass.*) *Petit.*

Sterile cells 3 to 9 times as long as broad. Fertile cells turgid, quadrate. Zygospore elliptical. Sporoderm brown.

SIZE. Cells ·024 to ·027 mm. Zygospore ·042-·048 mm. diam., $1\frac{1}{2}$ to 2 times as long.

Petit Spirogyra p. 8, t. 1, fig. 13. Bull. Soc. Bot. France xxi. p. 14, t. 1, fig. 2.

Zygnema quadratum, Hass. Alg. 157, t. 37, f. 1, 2. Jenner Fl. Tunb. Wells, 182.

Rhynchonema quadrata, Kutz. Tab. Phy. v. t. 32, f. 6.

In pools.

We have accepted Petit's diagnosis of this species, which Hassall had seen only with the *Rhynchonema* mode of conjugation, but which has now been ascertained to conjugate in both ways. His description is very short for a species which he says is "by no means uncommon," and he evidently depends as a specific feature on the quadrangular enlargements of the fertile cells. "Cells usually seven or eight times as long as broad. Sporangia oval, large, and much elongated, contained within quadrangular enlargements of the cells."

Plate XXXIX. fig. 1. *a,* fertile cells in conjugation with zygospore × 200, after Petit; *b,* zygospore in cell × 400.

Spirogyra Weberi. *Kutz.*

Sterile cells with the extremities replicate, 7 to 12 times as long as the diameter, chlorophyll bands single, 3 to 8 turns of the spiral.

Spores ovoid, scarce broader than the sterile threads, membrane even, chestnut, twice as long as broad.

Sporiferous cells scarcely turgid.

SIZE. Spores : (*a*) ·072 × ·034 mm. (*β*) ·068 × ·034 mm.

Cleve Monog. Zygn. p. 25, t. vii., f. 1-10.

form a. **inæqualis.**

Diameter of thread ·03 mm. Sporiferous cells scarcely longer than the spores.

Zygnema inæquale, Hass. Alg. 150, t. 32, f. 1 to 2.

Zygnema intermedium, Hass. Alg. t. 37, f. 3. Ann. Nat. Hist. x. (1842) p. 41. Jenner Fl. Tunb. Wells, 182.

Spirogyra inæqualis, Kutz. Tab. v. t. 30, f. 3.
Zygnema Grevilleanum, Hass. Alg. 149, t. 31, f. 1, 2. Hass. Ann. Nat. Hist. x. 38. Jenner Fl. Tunb. Wells, 180.

form b. **subventricosum.**

Sporiferous cells 2 to 4 longer than the spores. Diam. ·026 mm.
Spirogyra Weberi, Rabh. Alg. Eur. iii. 233.
Zygnema sub-ventricosum, Hass. Alg. 150, t. 32, f. 4, 5. Jenner Fl. Tunb. Wells, 180.
Zygnema diductum, Hass. Alg. t. 37, f. 4.
Rhynchonema diductum, Kutz. Tab. v. t. 32, f. 3.
Spirogyra ventricosa, Kutz. Tab. v. t. 29, f. 5.
Zygnema ventricosum, Hass. Ann. Nat. Hist. x. (1842) p. 38.
Zygnema longatum, Hass. Alg. 151, t. 31, f. 3, 4.

In ditches. Fruiting in summer.

The absence of any measurements, or uniformity in magnification in the figures, renders it very difficult to determine many of Hassall's species with any certainty. From present information we are unable to recognise *Z. Grevilleanum* as a distinct species.

Plate XXXIX. fig. 2. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospores × 200.

Spirogyra tenuissima. *Hass.*

Sterile cells with the extremities replicate, 5 to 15 times as long as the diameter. Chlorophyll bands single, making 3 to 6 turns of the spiral.

Spores broader than the sterile cells, elongated ovoid, twice as long as the diameter, membrane even and chestnut colour.

Sporiferous cells turgid.

[redacted]

Zygnema varians, Hass. Ann. Nat. Hist. xi. (1843) p. 431.
Conjugata inflata, Vauch. Conf. p. 68, t. 5, f. 3.
Zygnema inflatum, Hass. Alg. t. 32, f. 6, 7. Jenner Fl. Tunb. Wells, 180.
Zygnema Jenneri, Hass. Alg. t. 37, f. 6. Jenner Fl. Tunb. Wells, 182.
Zygnema dubium, Hass. Alg. t. 37, f. 7.
Spirogyra gastroides, Kutz. Tab. v. t. 29, f. 4.
Rhynchonema Jenneri, Kutz. Tab. v. t. 32, f. 1.
Rhynchonema dubium, Kutz. Tab. v. t. 32, f. 2.
Spirogyra inflata, Rabh. Alg. Eur. iii. 233.

In pools.

This species includes the most delicate of British species with replicate ends to the cells. In all the forms of both varieties there is an evident tendency in the fertile cells to become more or less inflated. The only difference which Hassall indicates between his *Z. inflatum* and *Z. tenuissimum* is one of size, which may be influenced by the circumstances of growth.

Plate XXXIX. fig. 3. *a*, sterile cells × 200; *b*, conjugating cells of variety *a*, with zygospores × 200; *c*, conjugating cells of variety *b*, with zygospores × 200; *d*, outline of zygospores × 400.

GENUS 46. **SIROGONIUM** *Kutz.* (1843.)

Cells with parietal longitudinal chlorophyll bands. Fructifying cells diverse, arising by unequal division of the thread-cells, bending knee-like towards each other and growing together, united at the point of adnation; receiving-cells barrel-shaped; giving-cells short, cylindrical. Zygospore (elliptic) in the receiving cell-wall.

The sterile cells, with parallel chlorophyll bands, resemble those of *Spirogyra*, but differ in the genuflexuous conjugation.

Sirogonium sticticum. *Kutz.*

Sterile cells 2 to 5 times as long as broad.
Zygospore broadly elliptical, spore-coat double.
Sporiferous cells swollen, abbreviated.
SIZE. Cells ·04 to ·05 mm., 2 to 5 times as long. Zygospore ·042 × ·075 mm.
De Bary Conj. p. 78, t. 2, figs. 1-6. Rabh. Alg. Eur. iii., 256.
Sirogonium breviarticulatum, Kutz. Tab. Phy. v. t. 4.
Sirogonium Braunii, Kutz. Tab. Phy. v. t. 4.
Conferva stictica, Eng. Bot. t. 2463.
Zygnema curvatum, Ag. Eng. Fl. v. 362. Harv. Man. p. 143. Eng. Bot. Ed. ii. t. 2512, f. A. Hassall Alg. 143, t. 26, f. 1, 2.
Choaspes serpentina, Gray Arr. 1, 299.

In ponds and ditches and moor pools.

"It forms large masses on the water, full of air-bubbles, being pale and yellowish above, and of a blackish green beneath. Filaments not lubricous, nearly equalling those of *Spirogyra nitida*, but with much longer articulations. When young the colour is of a dull pale green, and about three imperfectly spiral lines of shining granules are with difficulty distinguishable. Afterwards these lines become more conspicuous, the rest of the filament being now perfectly colourless, and their component granules larger, but their arrangement is still irregular. The filaments subsequently unite here and there, not by every articulation, and their connecting processes are usually nearer to one end of the vessicle than to the other. Such filaments are divaricated at the points of connection. In some of the combined articulations the contents appear unchanged, in others they form a mass of larger granules than in the lines, and some have a large oval sporidium which often swells the joint. Some traces of unchanged lines occur, now and then, in the fructifying vessicles."—*English Botany*, 2nd ed., p. 176.

Plate XL, fig. 1. *a*, sterile cells × 200; *b*, *c*, *d*, *e*, conjugating cells × 200; *f*, zygospore × 400. After De Bary.

GENUS 47. **ZYGOGONIUM.** *Kutz.* (1843.)

Cells cylindrical or barrel-shaped, with a compact, often many-layered glittering cell-wall. On each side near the middle an irregular chlorophyll-body, each furnished with a starch granule, both often confluent in an axile string (in the very thick-walled cells usually concealed by granules). Connection of the copulating threads ladder-like. The protuberances of the two contiguous inter-growing threads that receive the chlorophyll-contents are bounded by partitions into fructifying-cells, which then coalesce into a not-contracted zygospore.

Zygogonium ericetorum. *De Bary Conj. p.* 79.

Sterile cells, $1\frac{1}{2}$ to 2 times as long as broad.

[redacted]

var. b, **Aquaticum.**

Zygogonium didymum, Rabh. Hedw. 1, t. 3, f. 2.

Zygogonium Agardhii, Rabh. Alg. Eur. iii., p. 253.

Conferva purpurascens, Carm. Eng. Fl. v. 350. Harv. Man. 123. Mack. Hib. 224.

In pools, bogs, &c.

This is a very polymorphous species, some of the forms being terrestrial, and always sterile, others are aquatic producing zygospores. The old name of *Zygogonium erictorum* has been retained, but undoubtedly all these various forms belong to *Zygogonium Agardhii,* Rabh. (*Zyg. didymum,* R.)

"The colour, no less than the condition of the endochrome, varies considerably in this species. In some specimens the filaments are of a bright green, in which case they have always been found immersed in water; while in others, and more frequently, they are purple, of which colour they invariably are when found spreading over swampy heaths." —*Hass.*

Plate XL. fig. 2. Terrestrial form. *a,* sterile cells × 400 *Fig.* 3. var. *aquaticum. a,* sterile cells × 400; *b, c,* conjugating cells with zygospores × 400.

Doubtful Species.

Zygogonium gracile. *Berk.*

Sterile cells about five times as long as broad, of a pale or yellowish green colour.

Zygospore unknown.

Size. Cells ·014.-·016 mm. diam.

Rabh. Alg. Eur. iii., 255.

Zygnema gracile, Berk. Glean. t. 12, f. 3.

Face of a dripping rock.

Rabenhorst includes this with uncertain species of *Zygogonium,* but it seems more probable that it is a *Zygnema,* and perhaps one of the varieties of *Z. Vaucherii.* The following is the original description:—

"Pale dirty yellowish green, mucous; threads extremely fine, articulations not at all constant in length, 4 to 8 times as long as broad, marked in the centre with two approximate roundish globules. Slender filaments occur in the same mass, with joints longer in proportion, the green mass not divided into two distinct portions. I have not seen it conjugated."—*Berkeley.*

Plate XL. fig. 4. Sterile cells × 400.

Genus 48. **MOUGEOTIA.** *De Bary.* (1858.)

Cells with axile chlorophyll-plates. Copulation ladder-like. Zygospore drawn together in the swollen, bladdery, persisting middle space.

De Bary includes this genus in *Zygnemeæ,* although Wittrock joins it with *Mesocarpus,* and it seems to us very difficult to indicate any true generic distinction apart from the dividing off from the parent cells of the empty persistent cells which remain some time attached to the zygo-

spore; nevertheless we have not followed Wittrock in uniting *Mougeotia*, *Mesocarpus*, *Pleurospermum*, *Craterospermum*, and *Staurospermum* under the one genus, *Mougeotia*,, because we think that there are sufficient characters to warrant the retention of *Staurospermum* apart from *Mesocarpus*. If the mode of development in the following two species is accurately appreciated, this genus is more allied to *Zygogonium* than *Mesocarpus*. See Archer in Quart. Micro. Journ., 1866, p. 271.

Mougeotia glyptosperma. *De Bary Conj. p.* 78, *t.* 8, *f.* 20-25.

Sterile cells 7 to 12 times as long as broad.

Zygospores large, oval, with a thick, firm, yellow-brown epispore.

Sporiferous cells elongated.

SIZE. Cells ·01-·015 mm. 6 to 10 times as long. Zygospore ·016×·035 mm.

Rabh. Alg. Eur. iii. 255. Archer in Quart. Journ. Micr. Sci. 1866, p. 65.

As pointed out by Mr. Archer (*loc. cit.*) "this plant is not truly a *Mesocarpus*, but in its mode of conjugation more nearly approaches certain *Zygnemata*. It is no doubt related, on the one hand to *Mesocarpus* (Hass.); like it the endochrome forms a compressed longitudinal band, and like it too, the zygospore is formed half-way between the two conjugating joints. But, it is distinguished strongly by the fact that here the whole cell contents 'primordial utricles' and all, of the two conjugating joints completely coalesce, leaving the old cell-walls empty, in order to form the zygospore; whilst in *Mesocarpus* the contact of the primordial utricles of the two conjugating cells is not followed by a complete coalescence of the two into the zygospore; but by a concentration of the principal part of the green and solid contents in the connecting canal half-way between the two joints, and the shutting off thereupon of the residue of the pale granular contents remaining in each parent joint, the denser central portion becoming the spore, and that cut off on each side eventually becoming effete and lost. Hence in [redacted]

Mr. Archer has thus described the present plant:—"Cells short, varying from nearly quadrate to three or four times longer than broad, according to the interval of time elapsed since division; the contents bright herbaceous green, forming an axile compressed band (never separate stellate chlorophyll bodies as in *Zygnema*); the conjugation taking place by short wide processes, which, along with the shortness of the cells or joints, gives the pair of conjugating filaments somewhat the appearance of a perforated ribbon-like structure; the total cell contents of each pair of conjugating joints became massed together into an elliptic zygospore within the inflated transverse tube; the longer diameter of the zygospore placed vertically to the length of the filaments; the cavity occupied thereby not shut off by any septum from the cavities of the parent joints. It was evident that there was no septum separating the zygospore from the cavities of the parent cells, but it lay freely in the inflated transverse process, though frequently in contact with its walls about the middle."

Plate XLI. fig. 2. *a*, sterile cells × 400; *b*, fertile cells with zygospores × 200.

Sub-Family 2. MESOCARPEÆ.

Cells cylindrical, united in threads, with axile plates of chlorophyll. Zygospore the shape of the mother-cells; not contracted, separating by three to five partitions into a central firm-walled resting spore, and two or four lateral decaying cells.

The method of conjugation and spore-formation in the *Mesocarpæ* was not thoroughly understood until it was investigated and explained by De Bary ("Conjugaten," 1858), who first recommended the separation of the *Mesocarpeæ* from the *Zygnemeæ*, and their recognition as separate families. His exposition of the conjugation of the *Mesocarpeæ* is thus summarised by Wittrock* in a memoir submitted to the Swedish Academy:—"Two cells grow together in the common manner by conjugation outgrowths, and a resorption of the double septum between the two conjugating cells takes place. By this a cruciated or H-shaped double cell is formed, in which at first no other change takes place than that the canal of conjugation is somewhat widened, and that the chlorophyll-coloured part of the contents of the double cell moves into the canal of conjugation, and into the parts of the double cell nearest to the canal. This cruciated or H-shaped cell, thus formed immediately by the conjugation, De Bary regards as the zygospore of the *Mesocarpeæ*, and gives it the character of being 'not contracted' in contrast with the zygospore of *Zygnemeæ* and *Desmidieæ*. This zygospore exists, however, only for a very short time as such. The above-named moving of the chlorophyllaceous bodies (not of the whole protoplasmic mass) into the connecting canal having been accomplished, the zygospore is divided by two or four septa into three or five cells, of which one, the central one, is a hypnospore, rich in chlorophyllaceous protoplasm (and later in oil), whilst the two or four lateral cells, containing no chlorophyllaceous protoplasm, are sterile, and soon going to die. Thus the *Mesocarpeæ* have, according to De Bary, spores of two kinds, namely (1), zygospores, which are formed

* "On the Spore-formation of the Mesocarpeæ." By V. B. Wittrock. Stockholm, 1878.

simply by the growing together of the two conjugating cells, without contraction, and which do not *rest*, and (2) hypnospores (resting spores), which are formed by the partition of the zygospores, and which rest (as the name indicates) for a time before germinating. The *Zygnémeæ* and *Desmidieæ* have, on the contrary, according to De Bary, spores of only one kind, namely, typical zygospores, in the formation of which a fusion and contraction of the whole protoplasmic contents of the conjugated cells takes place, and which become hypnospores without a preceding partition."

Wittrock adds:—"To me it seems perfectly clear that De Bary is quite right in saying that the hypnospores of the *Mesocarpeæ* are not analogous to the zygospores of the *Zygnemeæ*, or in other words, that they are not zygospores at all. The hypnospores of the *Mesocarpeæ* are formed by partition, and not by an immediate fusion of the protoplasm of conjugating cells, as the case ought to be with zygospores."

He then proceeds to refer to Pringsheim's observations on this subject with commendation ("Jahrbucher" xi., 1877). "The act of conjugation may be divided into two different stages. The first, being properly speaking only introductory, consists in the two cells which participate in the conjugation growing together by conjugation outgrowths, and the septum between the cells thus growing together being resorbed. This part of the act of conjugation is what Pringsheim calls *copulation*. The second stage consists in an intimate fusion taking place of the protoplasmatic contents of the conjugating cells. This fusion is effected here in the *Mesocarpeæ* principally through the moving of the chlorophyll coloured parts of the protoplasm (the chlorophyllaceous bodies) into and to the neighbourhood of the somewhat widened conjugation canal. This second and more important stage of the fecundation Pringsheim calls *connubium*. The conjugation having taken place in this manner, its effect appears by the tripartition or quinquepartition of the cruciated or H-shaped cell formed by the copulation. Of the cells formed by this partition, the central one is fertile, the two or four lateral ones sterile. The result of the conjugation is consequently not one cell, but several cells, and not cells of one kind, but of two, namely, one propagative cell (a spore), and around it two or four cells not capable of germination. It would be difficult to find a reasonable interpretation of such a result, save the one suggested by Pringsheim, of its being a *sporocarpium*, and to me [redacted]

Genus 49. **MESOCARPUS.** *Hass.* (1845.)

Spore sphærical or oval, between two cylindrical, straight or slightly in-bent lateral cells. (*a*) Copulation ladder-like, threads free, or with one end attached; (*b*) copulation lateral between two neighbouring cells of a thread, rarely ladder-like. Sterile cells often with a knee-like bend, and intergrown at the bend with similar cells of another thread.

Including also the genera *Pleurocarpus* and *Craterospermum* of Braun.

† Spore membrane scrobiculate or punctate.
M. nummuloides, *Hass.*
M. depressus, *Hass.*
†† Spore membrane smooth.
M. parvulus, *Hass.*
M. recurvus, *Hass.*
M. scalaris, *Hass.*
Sub-gen. *Pleurocarpus*, Braun.
M. pleurocarpus, *De Bary.*

† *Spore membrane scrobiculate or punctate.*

Mesocarpus nummuloides. (*Hass.*) *De Bary.*

Sterile cells 7-14 times as long as broad. Zygospore spherical, or broadly ovoid; membrane brown, scrobiculate.

Size. Cells ·015 mm. diam. Zygospore ·044 × ·034 mm.

De Bary Conj p. 80, t. 8, f. 9, 10. Cleve Mon. Zyg. p. 30, t. 9, f. 4, 5. Hass. Alg. 169, t. 45, f. 1. Rabh. Alg. Eur. iii. 257.

Sphærocarpus nummuloides, Hass. Ann. Nat. Hist. xii. 187, t. 7, f. 12.

In ditches. Fruiting in September.

Plate XLI. fig. 3. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400.

Mesocarpus depressus. *Hass.*

Sterile cells 7-12 times as long as broad. Zygospore elliptical, compressed; membrane brown, punctate.

Size. ·007-·015 mm.

Hass. Alg. 168, t. 44, f. 1. Jenner Fl. Tunb. Wells 184.

Sphærocarpus depressus, Hass. Ann. Nat. Hist. xii. 186, t. 7, f. 11.

var. B. **ovalis.** *Rabh. Alg. Eur.* III. 257.

Mesocarpus ovalis, Hass. Alg. 169, t. 44, f. 2.

Sphærocarpus ovalis, Hass. Ann. Nat. Hist. xii. 189, t. 7, f. 15.

In boggy waters.

There seems to be no specific difference between the two species of *S. depressus* and *S. ovalis* of Hassall, the only feature relied upon being that the filaments in the latter are scarcely more than half the diameter of the former.

Plate XLI. fig. 4. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400. *Fig.* 5, var. *ovalis*. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400.

†† *Spore membrane smooth.*

Mesocarpus parvulus. (*Hass.*) *De Bary.*

Sterile cells 5-12 times as long as broad. Zygospore spherical; membrane even, commonly twice the diameter of the threads.

Size. Cells ·01 mm. Zygospore ·02-·024 mm.

De Bary Conj. p. 80, t. 2, f. 15. Cleve Mon. Zyg. p. 31, t. 9, f. 6, 7. Hass. Alg. 169, t. 45, f. 2, 3. Jenner Fl. Tunb. Wells 184.

Sphærocarpus parvulus, Hass, Ann. Nat. Hist. xi. 434, t. 7, f. 13, 14.

Mougeotia splendens, Kutz. Tab. Phy. v. p. 1.

var B. **angustus.** *Hass.*

Mesocarpus parvulus, var. *tenuissima*, De Bary Conj. t. 11, f. 10-14.

Mesocarpus angustus, Hass. Alg. 170, t. 45, f. 4.

Sphærocarpus angustus, Hass. Ann. Nat. Hist. xii. 187, t. 7, f. 16.

Mixed with other Algæ, in ponds, &c.

Plate XLII. fig. 3. *a*, sterile cells × 400; *b, c*, fertile cells, with zygo-

[redacted]

We can recognize no plausible grounds on which the *M. intricatus* of Hassall can be maintained as a species distinct from *M. scalaris*.

Plate XLII. fig. 1. *a*, sterile cells × 400; *b*, conjugating cells, with zygospores × 400.

Mesocarpus recurvus. *Hass.*

Sterile cells 5 to 10 times as long as broad.
Zygospore globose. Sporoderm brown, even.
SIZE. ·012-·018 mm. Zygospore ·023 mm. diam.

Hass. Alg. 168, t. 44, f. 1. Rabh. Alg. Eur. iii. 257.
Sphæricarpus recurvus, Hass. Ann. N. Hist. xii. 186, t. 7, f. 10.

In ditches.

Plate XLII. fig. 2. *a*, sterile cells × 400; *b*, conjugating cells with zygospores × 400.

Sub-Genus PLEUROCARPUS. *Braun.*

Mesocarpus pleurocarpus. *De Bary Conj. p.* 81.

Sterile cells 2 to 3 times as long as broad.
Zygospores subglobose, brown, even.
SIZE. Cells ·025-·03 mm. Zygospore ·03 mm. diam.

Pleurocarpus mirabilis, Braun. Alg. Uni. p. 60. Rabh. Alg. iii, 258.
Zygogonium pleurospermum, Kutz Tab. v. t 13.
Mougeotia genuflexa, Ag. and others. Eng. Fl. v. 360. Eng. Bot. Ed. 11. t. 2505. Jenner. Fl. Tunb. Wells, 182. Hass. Alg. 172, t. 40, f. 2. Harv. Man. 141. Mack. Fl. Hib. 231. Dickie Bot. Guide, 296.
Conferva genuflexa, Dillw. Conf. t. 6. Eng. Bot. Ed. 1, t. 1914.
Zygnema genuflexum, Johnst. Fl. Berw. ii. 257. Grev. Fl. Ed. 320.
Serpentaria genuflexa, Gray Arr. 1, 300.

var. **compressus.**

Mougeotia compressa, Eng. Fl. v. p. 360. Eng. Bot. Ed. 2, p. 172. Harv. Man. 141.
Zygnema compressum, Lyngb. Hyd. Dan. t. 58.
Serpentaria compressa, Gray Arr. 1. 300.
Pleurocarpus compressus, Rabh. Alg. Eur. iii. 258.

In moor pools, &c.

This widely diffused species forms vast yellowish-green masses, which Harvey says are often thirty feet in diameter; we have often met with them covering several square feet. The filaments are fragile, soon breaking into short lengths, bent almost at right angles and united at the angles, hence the old name of *Mougeotia genuflexa*.

Plate XLIII. fig. 1. Cells in conjugation × 400; *b*, fertile cells with zygospore, after De Bary × 400; *c*, *c*, zygospores × 400.

GENUS 50. **STAUROSPERMUM.** *Kutz.* (1843.)

Spores four cornered, between the truncated corners of four sessile lateral cells (cells of all the species up to twenty times longer than broad.)

† Sporoderm porose.
  S. quadratum, *Hass.*
†† Sporoderm verrucose.
  S. gracillimum, *Hass.*
††† Sporoderm smooth.
  S. capucinum, *Kutz.*
  S. viride, *Kutz.*

† *Sporoderm porose.*

Staurospermum quadratum. (*Hass.*) *De Bary.*

Sterile cells 10 to 20 times longer than broad.

Epispore quadrangular, with the angles truncate, not replicate, sides straight, covered with large pores (about 50 on the longer side).

SIZE. Cells ·015-·02 mm. Zygospore ·04-·044 mm.

De Bary Conj. p. 81, t. 8, f. 11. Cleve Mon. Zyg. p. 34, t. 10, f. 3. Rabh. Alg. Eur. iii. 259.

Staurocarpus quadrangulatus, Hass. Ann. Nat. Hist. xi. p. 434. Jenner. Fl. Tunb. Wells, 184.

Staurocarpus quadratus, Hass. Alg. 178, t. 48, f. 1.

Mougeotia quadrangulatus, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 3.

In ponds, ditches, &c.

[redacted]

††† *Sporoderm smooth.*

Staurospermum capucinum. *Kutz.*

Sterile cells 6 to 14 times as long as broad.

Zygospore quadrate, angles obtuse or truncate, sides often deeply sinuate. Sporoderm even.

SIZE. ·015 × ·02 mm. Zygospore ·05 × ·04 mm.

De Bary Conj. p. 81. Rabh. Alg. Eur. iii. 259.

Staurocarpus glutinosus, Hass. Alg, 177, t. 47, f. 1.

Staurocarpus cærulescens, Hass. Alg. t. 47, f. 2. Jenner Fl. Tunb. Wells, 184.

Mougeotia glutinosa, Hass. Ann. Nat. Hist. xxii. t. 7, f. 1.

Staurocarpus capucinus, Hass. Ann. Nat. Hist. xii. p. 184, t. 7, f. 2.

Mougeotia cærulescens, Eng. Fl. v. 360. Harv. Man. 141. Eng. Bot. Ed. 2, t. 2506.

Conferva cærulescens, Eng. Bot. t. 2457.

Agardhia cærulescens, Gray Arr. i. 299.

Leda capucino, Bory in Mong. & Nest. Ex. 793.

In ditches and ponds.

The filaments soon acquire a bluish tinge, and in drying assume a purple hue.

Plate XLIV. fig. 1. *a*, sterile cells × 400; *b*, conjugating cells with zygospores × 400.

Staurospermum viride. *Kutz.*

Sterile cells 10 to 20 times as long as broad.

Epispore quadrangular, angles truncate and replicate, sides concave, smooth.

SIZE. Cells ·008 mm. Zygospore ·025 mm.

De Bary Conj. p. 81, t. 2, f. 17-18. Cleve Mon. Zyg. p. 34, t. 10, f. 4-5. Rabh. Alg. Eur. iii. 260.

Staurocarpus gracilis, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 5. Hass. Alg. 179, t. 49, f. 1. Jenner Fl. Tunb. Wells, 184.

Staurocarpus virescens, Hass. Alg. 178, t. 48, f. 2.

Staurocarpus affinis, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 4.

Staurospermum franconicum, Reinsch. Algen. Fl. p. 217.

In ditches.

Plate XLIV. fig. 2. *a*, sterile cells × 400; *b*, conjugating cells with zygospores × 400; *c*, development of zygospores from conjugated cells × 400, after De Bary.

Sub-Family 3. GONATONEMEÆ.

Cells cylindrical, much elongated, united in threads, with axile plates of chlorophyll. Agamospores produced without conjugation in cells continuous with, and partitioned from the

Wittrock includes his single genus *Gonatonema* in the *Mesocarpeæ* as an agamosporous form, without ascertained conjugation. As an excuse for this he says:—"If we attached importance only to the neutral or sexual nature of the spore formation, as some of the modern systematizing botanists do even in the lower *Cryptogamæ*, we should be obliged to form a separate family for it, which might not even be placed in the class of *Conjugatæ*. To me the accordance with *Mesocarpeæ* as to the vegetative cells and the formation of the spores seems too great to allow the separation of *Gonatonema* from this family. It may not be unnecessary here to call to mind that the class of *Diatomaceæ* in which the formation of spores is in general effected through conjugation, does also embrace some genera where the spores are formed neutrally."

At the risk of condemnation as a "modern systematizing botanist," we do not feel content to include this genus in the *Mesocarpeæ*, and have therefore relegated it to a separate family until more complete evidence is furnished as to whether it really should be associated with the *Conjugatæ* at all, although its affinities seem to lie in that direction. All we are justified by the facts to assume is that it is an aberrant form, which, on the faith of its vegetative character may for the present be retained in proximity to the *Mesocarpeæ* until its relationship is better established.

Genus 51. **GONATONEMA.** *Wittrock.* (1878.)

Spores (agamospores not carpospores) without conjugation, formed by biseptation of the mother cells, which latter are bent angularly, and alternately, at the point of fructification.

Wittrock illustrates this genus by means of a species not yet ascertained to be British, but which he regards as congeneric with Hassall's species hereafter described. "Its vegetative stage consists of cylindric cells arranged in a single row. The membrane of the cells is very thin, and consists of pure cellulose. The bottoms of somewhat older cells are gently curved inwards, which gives rise to a small lens-shaped room between the cells. The contents of the cells consist of (1) a parietal thin colourless layer of protoplasm; (2) an axile cholrophyll-coloured rather thick band of protoplasm (the single chlorophyllaceous body of the cell) which runs through the whole length of the cell, and which is [redacted]

"The first sign of a beginning spore-formation is that the cell widens at its middle, so that this part resembles a cask. This widening is not, however, equally powerful on all sides, but is stronger on one side than on the other sides. At the same time the cell bends at its middle like a knee, so that its two halves form a more or less obtuse angle with each other. The point of the angle is placed where the before-mentioned more powerful widening of the cell has taken place. Almost always the formation of spores takes place at the same time in all the cells of a filament. Then it regularly occurs that the cells bend alternately in opposite directions, so that if cell No. 1 bends to the right, cell No. 2 bends to the left, No. 3 to the right, and No. 4 to the left again, and so on. Consequently the cells in a filament-producing spores will form a zig-zag line. Exceptions from this rule do, however, now and then occur; thus, that two cells abutting on each other bend in the same direction, after which the two next bend in an opposite direction and so on. When this occurs, the filament is gently curved like an S, alternately in two directions. When the spore-forming cell widens and bends, the chlorophyllaceous band of the cell is often interrupted at its middle part, by which the cell gets two chlorophyllaceous bodies instead of one. The chlorophyll-coloured protoplasm now begins anew to give proofs of its power of free motion. The chlorophyllaceous body (or bodies if there are two) moves freely and rather quickly, from the other parts of the cell to the widened middle part. When all of it has entered this part of the cell, which has thus become almost quite filled with chlorophyll-coloured protoplasm, the cell is divided into three cells by two septa, appearing one on each side of the chlorophyll filled central part. The cells formed by this partition are of two essentially different kinds. The two lateral cells have very little living contents. All the chlorophyll-coloured protoplasm is gone, and only the thin parietal layer of protoplasm and some drops of oil are left. The rest of the contents are only colourless cell-liquid. These cells have in fact filled their purpose. They soon die, and remain, as mere skeletons of cells, attached for some time (two or three weeks) to the central cell. The central cell is, in contrast to the lateral cells, very rich in living contents, having received all of the chlorophyll-coloured protoplasm of the mother-cell. It is also designed to become the hypnospore, through which the propagation of the species is to be affected. But before it becomes a complete hypnospore it is to pass through several stages of development. The first of these is that the cell-contents surround themselves with a new layer of cellulose (mesosporium) within the original one (exosporium). The mesosporium increases by-and-bye in thickness till it is considerably thicker than both the exosporium and the endosporium (which appears later). The mesosporium gets no sculpture (as is the case with so many *Mesocarpeæ*) it remains always smooth. But having been at the beginning hyaline, it soon assumes a faint yellow colour. Within the mesosporium a new layer of cellulose forms during the first week; this is called endosporium. It remains always hyaline and very thin. During this time the contents of the cell have also suffered a change. The chlorophyll-coloured protoplasm, at least the greater part of it, has changed into a fat oil, which is coloured in the same manner as the mesosporium, *i.e.*, a faint yellow. The hypnospore which is now ready, shows a somewhat different shape, if regarded from different sides. If regarded in the position it has when the curvatures of the spore-forming filament are directed to the right and left of the observer, the spore is, as a rule, non-symmetrically elliptic, with abrupt ends, very seldom it is almost circular. The want of symmetry consists in the spore being more convex on the side towards which the knee of the mother-cell has bent. If we imagine the spore being turned a quarter of a turn round its longitudinal axis, it appears somewhat

narrower, and perfectly elliptical, with abrupt ends. How the spores behave when germinating I have not yet had any opportunity of observing."

"Thus it appears from the foregoing details that the spores are always formed without a preceding act of conjugation. The spore formation, therefore, may be regarded as neutral, or we may assume that as in exceptional cases spores may be formed by the instrumentality of a single cell, in this case the exception has become the rule, and the spores would then be regarded as parthenospores, and not as agamospores."

Under these circumstances of development, Wittrock considers himself justified in proposing the genus *Gonatonema* for the two forms, the one *Gonatonema ventricosum*, on which the above observations were made, and the other the species which Hassall described as *Mesocarpus notabilis*.

Gonatonema notabile. (*Hass.*) *Wittr.*

Sterile cells 8 to 10 times as long as broad, sometimes longer.

Zygospore, front view cylindrical, side view bent so as to be convex on one side, concave on the other, truncate at the ends, same diameter as the vegetative cells.

SIZE. Cells ·012-·015 mm.

Wittrock Mesocarpeæ, p. 16, fig. 14.
Mosocarpus notabilis, Hass. Alg. 170, t. 46, f. 2.
Mougeotia notabilis, Hass. Ann. Nat. Hist. x. p. 46.
Staurospermum notabile, Rabh. Alg. Eur. iii. 261.

Found in great abundance in some brick fields near Notting Hill.—*Hassall.*

Here follows the original description by Hassall:—"Filaments at first cylindrical, but subsequently becoming angulated, the angle of flexion being situate in the centre of each cell. Cells usually about 8 or 10 times as long as broad, but frequently longer. Sporangia non-symmetrical, a single one being placed in the angle formed in each of the cells."

We have nothing to add to this description, never having seen the

Order III. *SIPHOPHYCEÆ.*

Unicellular algæ, usually at the time of fruiting bicellular. Cells utricle-shaped, often prominently branched; branches with terminal vegetation, at length shut off by a septum, some transformed into oosporangia, others into antheridia. Cell contents green, mucilaginous, granulose, filled with chlorophyllose vesicles and starch granules.

Propagation by free cell formation, or zoogonidia, or oospores.

Plants aquatic or terrestrial, some marine.

Family I. Botrydiaceæ.—Propagation by free cell formation and by zoospores.

Family II. Vaucheriaceæ.—Propagation by oospores and zoogonidia.

Family I. BOTRYDIACEÆ.

Plants small, terrestrial, unicellular. Cell in the beginning globose, afterwards clavate or pyriform, and inflated; vertex rounded, a long time closed, attenuated downwards; base divided into delicate hyaline radicles, filled within with a mucilaginous green granulose cytioplasm, with age collapsing at the apex, and finally wasting away. Cell contents modified into an indefinite number of resting spores; spore contents, in germinating, becoming modified into a number of sexual zoospores conjugating and forming isospores.

Genus 52. **BOTRYDIUM.** *Wallr.*

Vegetative plants unicellular, increasing by cell division and zoospore formation; asexual uniciliate zoospores; sexual biciliate isospores, sometimes globular, and alike capable of germination, sometimes compressed and hexagonal, furnished with a few tuberculate thickenings.

See for information Braun's "Rejuvenescence," pp. 128, 193, 220, 274; Parfitt in "Grevillea," Vol. i., p. 103; Archer in "Grevillea," Vol. i., p. 105; Rostafinski and Woronin, "Ueber Botrydium granulatum," 1877; Lawson in "Trans. Bot. Soc., Edinburgh," vi., 424; Archer in "Quarterly Journal of Microscopical Science," 1878, pp. 446-452.

The following is a summary of Rostafinski and Woronin's researches on this genus :—

If a plant be placed in water, its contents become modified at the latter part of the day or at night into zoospores. Ultimately the wall swells, then bursts somewhere at the top, and the zoospores resulting from the division of the parietal stratum escape. If the plant be only moistened, the zoospores do not swarm out, but come to rest within the collapsed wall. Such were known to previous observers as "germ cells" or "gonidia."

The zoospores are elongate-oviform, 5-8 × 20 mm., with a single flagellum, and 2 to 4 chlorophyll granules. Having swarmed out, they soon come to rest, lose the flagellum, become surrounded by a membrane, increase in size, and germinate on damp earth, in which stage they represent the so-called *Protococcus botryoides*.

The large ordinary zoosporangia, are also otherwise modified. If one is allowed to dry, its membrane collapses, loses colour, and soon becomes empty. The protoplasmic contents pass down to the ramifications of the root. Here they break up into numerous cells, sometimes two or three side by side, but chiefly in a continuous chain ; each cell furnished with a separate membrane.

These are capable of three forms of development :—(1) If removed from the soil and placed in water, the cell becomes a subterranean zoosporangium. The formation of the zoospores is independent of light at any hour of the day or night. The zoospores are similar to those above described, and germinate in the same manner. (2) If a chain of these root cells be laid on moist earth, each protrudes a hyaline process, which enters the soil, the opposite end being elevated, and thus each root cell becomes a vegetative plant. (3) If the root cells are not removed, and kept equably moist, they also germinate in the earth, become inflated, put forth a root process, the wall of which becomes very much thickened on the inner side below the inflated upper portion. By interculary growth of the root portion the upper part becomes raised aloft, so that the apex is carried above the surface of the soil. These products of modified root cells are named *hypnosporanges*, and are equivalent to so-called *Botrydium Wallrothii*. When dried, the hypnosporanges retain their power of germination during the whole year, and when placed in water form zoospores at any hour of the day and night,

[redacted]

of slightly coloured protoplasm. These zoospores conjugate in twos, sometimes several together. They come in contact by their ciliated ends, then come to touch laterally by the uncoloured portions, when the fusion of the conjugating zoospores takes place, immediately after which they present a cordate figure, and in the middle a colourless vacuole. Finally, the *isospore* thus originating becomes globular, the vacuole occupying the centre.

If the zoospores be isolated before conjugation, they will in the end break up, without presenting any products capable of germination.

The zoospores originating from red spores have a different figure, their posterior end being rounded, but they have otherwise the same structure, and behave in the same manner as the others. The red spores maintain their germinative power for years, but after two years their zoospores are languid, and offer a parthenogenesis of a peculiar kind. The red spores, if kept moist only, become nothing altered after weeks, whilst the green, under these circumstances, may directly germinate into vegetative plants.

The *isospores* are at first globular, and capable of immediate germination. They also present resting stages, the original form becoming modified. Soon after conjugation these are flattened, with irregular lateral boundaries, which become on the following day hexagonal. The membrane becomes thickened, and presents tuberculations at the margin, but no secondary membrane is formed. Brought upon damp earth, they soon become globular, and otherwise behave as ordinary isospores.

In order to distinguish that which appertains to the cycle of alternation of generations from the rest, the simple method is to start from the fertilized germ, and see what are the modifications which are essential in order to arrive again at the same reproductive process. In this case we have the isospore—it germinates—produce the vegetative plant, which needs neither to divide, nor produce a sexual zoospore, nor to become an ordinary zoosporange—it can directly produce spores. These close the first generation. The second oospore generation occurs in the germination of these spores in the form of sexual zoospores, which directly lead to the formation of the isospore—the limits of two generations. All the rest are but phenomena of adaptation.

"Thus, in nature, the vegetative plants in spring almost all become zoosporangia, and spread the growth over considerable areas. Zoospores which fall into the water are not lost; they acquire a double membrane, and lie dormant until they chance mechanically to arrive on moist soil. If drought sets in, the plasma retreats to the roots; if the earth be some time a little moist, the root cells become hypnospores, awaiting the rain in order to develop multitudes of zoospores; but if the earth becomes rapidly dried, the root cells remain unaltered, until a moistening excites the formation of zoospores. A great many of the root cells can manifestly accidentally reach the surface of the soil, and thus, according to the state of the moisture of the earth or of the air, sometimes germinate, sometimes become zoospores." All this in the spring. The hotter months favour the formation of spores, but at that time only the vegetative plants are mostly to be found, either undergoing cell division or spore formation. They can also furnish uniciliate zoospores without becoming modified into ordinary zoosporanges.

Formation of ordinary zoospores may be accomplished in a fourfold way—

1. From the vegetative plant.
2. From the ordinary zoosporange.
3. From the root cell.
4. From the hypnosporange.

Further modes of increase are—

5. Cell division.
6. Formation of spores.
7. Formation of zoospores.

This plant possesses also fivefold resting stages—

1. Of the asexual zoospores laid in water—for months.
2. Of the root cells—the year throughout in which they originated.
3. Of the hypnosporanges—the year throughout in which they originated.
4. Of the spores—for years.
5. Of the isospores—at least over the year in which they originated.

Plate LXV., Botrydium granulatum. Fig. 1, plants of the natural size. Fig. 2, zoosporangium × 30. Fig. 3, the same, five hours afterwards, with the zoospores escaping at the apex, ×·30. Fig. 4, zoospores × 520. Fig. 5, differentiation of the plasma in the root, and the formation of root cells, × 30. Fig. 6, root cells in water producing zoospores × 160. Fig. 7, the resulting zoospores × 520. Fig. 8, the same, 24 hours after swarming, × 520. Fig. 9, the same, four days later, × 520. Fig. 10, the same, eight days later, × 520. Fig. 11, copulating swarmspores × 520. Fig. 12, zoospores derived from a spore, after six and a half hours, × 160. Fig. 13, sexual swarmspores in conjugation × 520. Fig. 14, isospores, 24 hours old, × 520. Fig. 15, stellate isospores, more than a day old, × 520. Fig. 16, young plant resulting from vegetation of isospore. All after Rostafinski and Woronin.

Botrydium granulatum. *Linn.*

Usually gregarious, often aggregated, rarely confluent; cells globose, pyriform, size of a poppy seed, or mustard seed, or larger, leek-green, apparently pulverulent.

Botrydium granulatum, Jenn. Fl. Tunb. Wells 176. Parfitt in Grevillea i., p. 10. Eng. Fl. v., p. 321. Harv. Man. 150. [redacted]

or two principal roots, which become gradually ramified into many fine rootlets; the chlorophyll contents at the beginning dense and homogeneous, and clothing the inner cell membrane, extend only to the neck of the root; the membrane is rather rigid. Upon being broken the cell contents become extruded, the membrane collapses as a thick pellicle, whose contents admit of being completely pressed out. The fluid contents in this condition consist of finely granular plasma, tinged by chlorophyll granules. Subsequently the green plasma layer becomes separated from the membrane, breaks up into single equal-sized portions, which become rounded off, coated with a membrane, and gradually individualized as daughter-cells. At last the entire globose cell is densely filled with rounded daughter-cells; whilst, previous to this state, the plant presented an intensely grass-green colour, it shows in this latter state a clear or sea-green colour. Mature and immature plants hence readily admit of being distinguished by the tint with the unassisted eye. The membrane of the mother individual at last passes to decay; it collapses, and the daughter-cells become the germs of new individuals in the soil. The maturity of the individuals occurs towards autumn, and accordingly the germ cells lie resting in the earth during winter, and germinate in the following spring. The development of the germ cells to new individuals takes place without formation of a 'prothallus' ('ohne Vorkeimbildung'). One end elongating as a root, at once penetrates the earth; the other end becomes developed as the above-ground portion. The diameter of a ripe germ cell is 0·009-0·012 mm. The plants prefer to establish themselves on the surfaces of the large clefts which are produced when the waters retreat and the ground becomes gradually dried by the air."—*Reinsch. Algen Flora,* p. 218.

See also "Grevillea" Vol. iv., p. 105, since which period the Memoir by Rostafinski and Woronin has appeared, and that has pretty well established the complex character of reproduction in this little plant.

FAMILY II. VAUCHERIACEÆ.

Algæ monœcious (rarely diœcious), cæspitose, unicellular or bicellular. Thallus with terminal vegetation, utricle-shaped, elongated, more or less branched.

Propagation either sexual, by oospores fecundated by spermatozoids, or non-sexual by zoospores.

Sporangium terminal, formed by the globosely clavate swelling of the tip of the thallus, cut off by a septum, contents dark green, at length enclosing one large zoospore, densely clad with vibratile cilia.

Oogonium lateral, sessile, or borne on a more or less elongated simple, or partite, pedicel; cytioplasm at length converted into a large oospore.

Antheridium lateral, sessile, or cut off by a septum from the upper portion of a lateral branch, in which numerous spermatozoids are generated, which at length become free. Spermatozoids oblong, furnished with two unequal cilia (except in one species).

Consult Thuret in "Annales des Sciences Naturelles, Botanique," 1843. Walz in Pringsheim's "Jahrbucher" for 1866. Braun "Rejuvenescence," pp. 128, 140, and following.

GENUS 53. VAUCHERIA. *D. C.* (1805.)

Characters the same as given above for the Family.

Two or three arrangements of the European species of *Vaucheria* have been proposed, differing slightly in detail. The following is that of Professor Nordstedt:—

VAUCHERIA.

A. Antheridia not separated from the thallus by a short empty boundary cell.

a TUBULIGERÆ. Antheridia little or scarcely bent, oblong cylindrical, or lanceolate, with an opening at the top. Red pigment bodies *not* collected in the middle of the mature oospore. Oogonia and antheridia almost stemless.

* Oogonia nearly round.

1 *V. dichotoma* (L) Diæcious.

2 *V. Thuretii* Wor. Monæcious.

** Oogonia not round, more or less oval, frequently rather oblique.

3. *V. aversa*, Hass.

4. *V. sericea*, Lyngb.

b CORNICULATÆ. Antheridia bent in the form of a horn, or a hook, placed on the short and bent side branches of the thallus. Brown pigment in the middle of the mature oospores.

aa *Sessiles*. Oogonia sessile (or with exceeding short stems) beside the antheridia on the thallus.

5. *V. Dillwynni*, Ag.

6. *V. sessilis* (Vauch).

bb *Racemosæ*. Antheridia at the end of a fruit branch, which somewhat lower down, carries the

B. Between the antheridia and thallus itself is found a shorter empty boundary cell (not containing chlorophyll).

a ANDROPHORÆ. Several horn-shaped bent antheridia placed on a swollen cell containing chlorophyll, which is fixed to the side of the thallus, by means of the boundary cell.

12. *V. synandra*, Woron.

b PILOBOLOIDEÆ. Antheridia bordering immediately on the boundary cell (frequently provided with several mouths).

aa Oogonium borders immediately on the thallus branch.

* Several fructification tubes on the oogonium.

13. *V. coronata*, Nordst.

** Oogonium with only one fructification opening, but the antheridia with several.

† Oospore round.

14. *V. intermedia*, Nordst.

15. *V. sphærospora*, Nordst.

† † Oospore lens-shaped.

16. *V. piloboloides*, Thur.

bb Below the oogonium a boundary cell.

17. *V. litorea*, Hofm.

Place uncertain.

18. *V. tuberosa*, Br.

19. *V. trifurcata*, Kutz.

The sexual reproduction in *Vaucheria* has been minutely described by Pringsheim, of which we give an abstract. *Vaucheria*, besides the asexual multiplication by zoospores also exhibits a true sexual propagation, effected by means of the two organs known as the "hornlets" and the spores, the latter being more correctly termed "sporangium." Both organs arise like papillary branches from the tube, and in close proximity. It is usually the case that the papilla destined to become the hornlet is formed sooner than that in which the sporangium originates. The two papillæ even from the first differ so widely in dimensions, that they can scarcely be confounded. The papilla which becomes the hornlet soon elongates into a short cylindrical slender branch, which at first rises perpendicularly from the tube, then curves downwards until it comes in contact with the tube, often forming a second, or a third curve, and in this way always represents a more or less stunted branch, which frequently exhibits several spiral turns. The papilla of the neighbouring sporangium usually begins to appear at the time when the hornlet is commencing its first turn; but the period at which it arises is very indeterminate, for it sometimes appears much earlier, whilst the hornlet is still perfectly straight, sometimes much later after it has curved, so as to form two limbs of equal length.

The papilla destined to become the sporangium gradually enlarges into a considerable-sized lateral out-growth of the tube, far exceeding the hornlet in width, whilst in length it is barely equal to the straight limb of the latter. This out-growth which is afterwards symmetrical, ultimately throws out a beak-like prolongation on the side looking towards the hornlet, the rostrum of the sporangium, whence the latter acquires its peculiar form, resembling that of a half developed vegetable ovule. Up to this period the hornlet as well as the sporangium are not shut off from the tube by any septum; the cavity of the hornlet and that of the sporangium consequently remain uninterruptedly continuous with the parent tube, and are filled with similar contents. A number of chlorophyll granules in an albuminous plasma and rounded oil globules, constitute a dense lining to the tube, the sporangium, and the hornlet. Between this and the cellulose membrane is the thin colourless cutaneous layer.

At this stage a septum is suddenly formed at the base of the sporangium, which is henceforth an independent cell, completely separated from the parent tube. Even before this septation there may be noticed in the rostrate elongation directed towards the hornlet, the gradual accumulation of a colourless fine granular substance, of the same nature as that with which the wall of the parent tube, and the sporangium is lined on the inner surface, which has already been termed the "cutaneous layer." This accumulation in the fore part of the rostrum is continued after the formation of the septum between the sporangium and the tube, and in consequence of its continued increase, the remaining contents of the sporangium are by degrees pushed back towards the base. Whilst these phenomena are being manifested in the sporangium, the hornlet also undergoes remarkable changes. In its apex, the contents, owing to the disappearance of the chlorophyll, have become almost colourless, more or less. Thus the point of the hornlet, like that of the sporangium, appears at this time to be filled with a colourless substance, which is *not* constituted by an accumulation of the cutaneous layer, but manifestly arises from a molecular change associated with an alteration of form and colour in the contents previously existing at the apex. So soon as the contents at the point of the hornlet have thus become colourless, they appear to be constituted of a very fine-grained granulose mucous substance. As soon as the transformation of the contents has taken place, the colourless apex of the hornlet is suddenly separated from the lower green portion by a septum, and is thus transformed into an independent cell, without communication with the parent tube. The point at which the septum is formed is not very determinate, the portion cut off being sometimes larger, sometimes smaller.

After the formation of the septum in the hornlet the colourless mucous in its apex gradually assumes a more determinate form, and at this time a large number of minute, perfectly colourless, rod-like bodies may be readily perceived crowded together irregularly, and as it were imbedded in the surrounding mucous. Close observation will disclose an indistinct movement exhibited even thus early by some of the little rods, from which their destination may be anticipated.

This perfecting of the hornlet coincides with that stage of development of the sporangium at which the accumulation of the cutaneous layer in

In great number (20, 30, or more) they enter the neighbouring orifice of the sporangium, which they fill almost entirely, penetrating through the portion of the cutaneous layer remaining, which, though without any definite boundary, offers a solid resistance to their further penetration into the sporangium. The corpuscles continue thus to struggle forwards into the cutaneous layer for more than half an hour, bounding against its outer surface they retreat, again push forwards, again retreat, and so on, in an uninterrupted succession of assaults and retreats.

After this commotion has lasted some time, an abrupt boundary line suddenly appears in the outer aspect of the cutaneous layer, the first indication of a tunic forming around the contents of the sporangium which were before bare. From this moment the mobile corpuscles are separated from the cutaneous layer by a membrane which effectually prevents their further action upon the contents. They continue, it is true, to move to and fro, and this movement often lasts for hours together, but at last they perish in the rostrum itself. Even after the lapse of several hours the dead corpuscles may be seen in the rostrum, lying on the front of the sporangium, until at last they are completely dissolved, and all vestige disappears.

The cutaneous layer surrounding the green contents of the sporangium becomes transformed, after impregnation, into the coat of the true spore, which, thus formed, represents a large cell occupying the whole of the sporangium, surrounded on all sides by the persistent tunic, which is open in front and prolonged into the rostrum.

In this condition the spore remains for some time longer without being thrown off from the parent tube on which it was produced, but the colour of its contents gradually becomes paler and paler. The spore is at last rendered quite colourless, and presents in its interior only one or more largish dark brown bodies. When it has lost all colour it is detached from the parent tube, in consequence of the decay of the membrane of the sporangium enclosing it. After some time, say three months, the spore suddenly resumes its green colour, and immediately thereupon grows into a young *Vaucheria* exactly resembling the parent plant.

An abstract of the memoir from which the above details were obtained was published in the "Quarterly Journal of Microscopical Science" for 1856. (Vol. iv., p. 63).

During the present winter Mr. Frederic Bates, of Leicester, has called our attention to some plants of *V. sessilis*, taken from beneath the ice in a pool. The first feature which presented itself was the septation of the threads, many of them being divided into numerous articulations three or four times the length of the diameter in the upper portion of the thread, but longer below. This unusual septation, as it appears to be, was general throughout the gathering, but the threads bearing oogonia were more rarely divided, but sufficiently so to remove any doubt as to the threads being genuine threads of *Vaucheria*, which at first we must confess to have doubted. The question which next arose was as to the purpose for which this septation had taken place, and an answer suggested itself in the collection of the cytioplasm into denser masses towards the centre of the cell, with most evident differentiation into oval bodies, resembling zoogonidia in course of formation. The time of observation has been short, but long enough to raise a suspicion in our minds that another form of fructification, by means of zoogonidia, takes place in *Vaucheria*, and the occurrence of germinating spores in various early stages in the water in which the *Vaucheria* was being preserved, lends strength to this suspicion. It is quite true that *Vaucheria* has been often and patiently studied, and no intracellular swarm-spores detected; yet it may be possible that, under certain conditions, they may be produced. We are patiently waiting in hopes of obtaining active zoogonidia.

The plates for this part were all in course of printing when the above observations were being made, so that it was too late to insert figures of the septate threads and their contents.

Plate XLVI. Figs. 1-20. Impregnation of *Vaucheria sessilis* after Pringsheim × 200.

Figs 1-4. Stages of development of sexual organs before impregnation. Fig. 5. During impregnation. Figs. 6-8. The way in which the female organ opens the cutaneous layer, bursts through, and a portion is constricted off. Fig. 9. Approach of spermatozoids before formation of the membrane of the embryo cell. Fig. 10. Point of female organ after formation of the membrane of the true spore. Figs. 11-12. Later conditions of spore after impregnation. Figs. 13-16. Male and female organs after impregnation. Fig. 17. Colourless spore after it is detached from the parent tube. Fig. 18. Detached spore, which after resting three months has become green. Figs. 19-20. Germination of the green spores.

a. TUBULIGERÆ. *Antheridia little or scarcely bent.*

1. Vaucheria dichotoma. *Lyngb. Hydro. Dan. p.* 75, *t.* 19.

Robust, loosely cæspitose, dirty green, or becoming brownish. Thallus very thick, setaceous, nearly a foot long, remotely dichotomous. Oogonia sessile, globose, or ovoid, single, scattered, or 2 to 4 to 6 approximating. Oospores, when mature, with a triple membrane, spotted with brown. Antheridia single, erect, oval, sub-clavate, or acute, on the same or on different threads.—*Rabh. Alg. Eur.* III. 268.

SIZE. Oogonia ·1 mm. diam. Threads ·2 mm. diam.

Walz in Pringsh. Jahrb. p. 152, t. xiv. f. 28-33. Fl. Danica t. 1724. Harv. Man. p. 147. Grev. Br. Alg. p. 190. Gray. Arr. i., 289. Kirsch. Alg. Schl. p. 82. Eng. Bot. ii., t. 2418. Grev. Fl. Ed. 305. Mack. Hib. 233. Fl. Devon ii., 56. Kutz. Tab. vi., t. 56a. Hass. Alg. t. 4, f. 1. Eng. Fl. v., p. 319. Nordst. Bot. Not. 1879, p. 184. Jenner Fl. Tunb. [redacted]

Plate XLVI. fig. 21. Oogonia of *Vaucheria dichotoma* × 100 diam. Fig. 22. Oogonium × 200. Fig. 23. Antheridea × 100. Fig. 24. Antheridium × 200, after Woronin. Fig. 25. Germinating spore.

Plate XLIX. figs. 5, 6. The *V. submarina,* Berk., generally referred to this species as a variety.

2. Vaucheria aversa. *Hass. Alg. t.* 6, *f.* 5.

Loosely cæspitose, sparingly branched, expanding in all directions, organs of fructification similar to those of *V. sericea,* but with the thallus much thicker, the oogonia larger, and suberect, now and then somewhat pedicellate; oospores much smaller.

Hass. Ann. Nat. Hist. xi. (1843), p. 429. Walz in Prings. Jahrb. p. 151, t. 13, f. 25-27. Cleve. Vauch. 133, f. 7.

Vaucheria rostellata, Kutz. Tab. vi., t. 58, f. 4.

In ditches.

Hassall describes this species as "Capsules usually in pairs, and in the form of a bird's head, with the beaks averted from each other. Sporangia circular, not entirely filling the cavity of the capsule." To this he adds, "It is one of the best marked, and most peculiar of the genus, the beaks of the capsules being turned in opposite directions, at once distinguish it from all other known species, in which, when the vesicles are in pairs, they are directed towards each other. This averted position of the capsules renders the existence of a distinct horn or anther essential for each. In the form of the seed-vessels and in the circumstance of the sporangia not filling the entire cavity, the species resembles *V. ornithocephala*" (now regarded as a variety of *V. sessilis*).

Plate XLVII., fig. 1. Oogonia and antheridia of *Vaucheria aversa* × 100. Fig. 2. The same × 200. Fig. 3. Mature oospore in oogonium × 200, after Walz.

3. Vaucheria sericea. *Lyngb. Hydro. Dan. t.* 21, B.

Tufts densely interwoven, yellowish, dirty green, or becoming brownish; thallus thin, loosely and vaguely branched; oogonia 2 to 6 in a series, one sided, oblique oval, rostellate, mouth produced laterally, sessile or shortly pedicellate; antheridia cylindrical, or rather clavate, horizontally deflexed. Spermatozoids oblong, with a red spot, furnished with a cilium at each pole.

SIZE. Oogonia ·1 mm. diam.

Walz in Prings. Jahrb. p. 150, t. xiii., f. 20-24.

Vaucheria ornithocephala, Ag. Sp. Alg. p. 467. Grev. Alg. Br. p. 193. Harv. Man. p. 148. Rabh. Alg. Exs. No. 1100. Nordst. Bot. Not. 1879, p. 184.

Vaucheria polysperma, Hass. Ann. Nat. Hist. xi. (1843), 429. Hass. Alg. t. 6, f. 6. Kutz. Tab. vi., t. 58, f. 5. Rabh. Alg. Exs. No. 1375. Cleve Vauch. p. 7.

In ditches, &c.

This is the *Vaucheria polysperma* of Hassall, who says of it: "It is by no means uncommon, and may be distinguished from all others known to me by the fineness of its filaments, which are not half so large as those of our other British species, no less than by the form and arrangement of the sporangia. These are slightly pedunculate, varying in number from 3 to 5, but usually there are but three, the apices or beaks of which are neither turned towards or averted from each other, but are all directed one way. The resemblance which the capsules bear to a bird's head when viewed sideways is very remarkable, and this resemblance is rendered still more striking by the fact that the circular sporangium occupying only the central portion of each, and which therefore represents the eye of the bird.'

Plate XLVII., fig. 4. Oogonia and antheridia of *V. sericea* × 200. Fig. 5. Oogonia containing oospores × 200. Fig. 6. Mature oospore enclosed in an oogonium × 200, after De Bary. Fig. 7. Zoospore × 200, after Walz. Fig. 8. Spermatozoids.

b. Corniculatæ. *Antheridia bent in the form of a horn or a hook, seated on short lateral branches.*

4. Vaucheria Dillwyni. *Ag.*

Terrestrial, broadly expanded, forming a rather thin stratum, of bright or dark green colour. Oogonia globose, or ellipsoid, rostrate, sessile, usually single, sometimes in twins, enclosed in delicately punctate membrane. Mature oospores spotted with brown, sporoderm very thick, composed of several strata. Antheridia bag-shaped, formed from the apices of short lateral curved branches, either approximate to the oogonia or seated between a pair of them.

Rabh. Alg. Eur. iii., 269. Grev. Alg. Britt. t. xix. Hass. Alg. t. 4, f. 3. Eng. Fl. v., p. 320. Jenner Tunb. Wells 176. Eng. Bot. ii., p. 124. Harv. Man. 147. Johnst. Fl. Berw. ii.,

Plate XLVII., figs. 9, 10. Oogonia and antheridia of *V. Dillwyni* × 200. Fig. 11. Oogonium of the same × 200. Fig. 12. Mature oospore enclosed in membrane of oogonium × 230, after Walz. Fig. 13. Spermatozoids.

5. Vaucheria sessilis. *Vauch. Conf. p.* 81. *pl.* 2, *f.* 7.

Loosely intricate, pale or rather dull green. Thallus capillary, sparingly branched; oogonia 2 to 3 approximate, rarely single, ovate or oblong-oval, more or less oblique, rostrate; antheridia intermediate, either short, hamate, or straight and subulate, or a little clavate, sometimes elongated and incurved, rarely circinate. Mature oospores punctate with brown, involved in a triple membrane.

SIZE. Oospore ·07 mm. diam., thread ·07 mm. (Cleve).

Eng. Fl. v., 320. Cleve Vauch. 133, f. 6. Kirsch Alg. Schl. 82. Walz Vauch. p. 145. Kutz. Tab. vi., 59, f. 2. Hass. Alg. t. 4, f. 2. Eng. Bot. t. 1765. Harv. Man. p. 148. Grev. Alg. Br. p. 192. Jenner Tunb. Wells 176.

Vaucheria sphærocarpa, Kutz. Tab. vi., t. 59, f. 1.

Vaucheria racemosa, Rabh. Alg. Sachs. No. 495.

Vaucheria Ungeri, Thur. Ann. Sci. Nat. xix. (1843), t. 11, 12, 13, f. 37-42 and 44.

Sporangia.—

Vaucheria clavata, Vauch. Conf. t. 3, f. 10. Hass. Alg. 59, t. 2, f 20-33. Harv. Man. 149. Berk. Glean. t. 10. Gray. Arr. i., 290.

In ditches, or on the ground.

var. a. **cæspitosa.** *Vauch. Conf. p.* 26, *t.* 2, *f.* 4.

Oogonia usually in pairs, ovate, opposite. Antheridia intermediate, generally short, circinate.

Vaucheria cæspitosa, Carm. Eng. Fl. v., p. 321. Eng. Bot. 1, t. 2841, ii., t. 2421. Hook. Fl. Scot. ii., 92. Jenner Tunb. Wells, 176. Grev. Alg. Britt. 194. Harv. Man. 148. Johnst. Fl. Berw. ii., 251. Hull Br. Fl. 330. Abbot. Bedf. 275. Mack. Hib. 234. Gray Arr. i., 291.

Conferva amphibia, Dill. Conf. t. 41. With. Arr. iv., 129. Huds. Fl. Ang. ii., 594. Lightf. Fl. Scot. 979. Sibth. Ox. 336.

Conferva amphibia fibrillosa et spongiosa, Dill. Musc. t. 4, f. 17.

Conferva terrestris exilis fibrillosa, Ray. Syn. 59.

On the margins of streams or pools.

"Fronds densely interwoven into cushion-like tufts or strata of indefinite extent, irregularly branched, the tips erect, giving the surface the appearance of bright green velvet."—*Harvey.*

Dillwyn's description of his *Conferva amphibia* seems to be most applicable to this species. "On the edges of ditches, and in similar situations, it frequently occurs in masses so densely matted as to hold water like a

sponge, with its surface beset by erect branches which give it a very bristly appearance. In this state it is well known to botanists as the *C. amphibia* of all modern authors. Its hue is of a bright green, becoming ash-coloured with age. The root I have not been able to discover, and the entangled mode of its growth renders it impossible to ascertain the length of the filaments. These are repeatedly divided with distinct patent branches, which, as before mentioned, when the plant grows in shallow water, so that some of them are exposed to the air, send out patent ramuli, of a stunted growth, from being out of their proper element, which by their erectness give the plant its bristly appearance; yet at the same time, if whilst in this state the waters rise so as to overflow the plant, their length is gradually increased, and losing their erect position they yield to the current, and become the *Ceramium cæspitosum* of Roth; and after having thus changed, if by the subsidence of the waters the surface is again exposed to the air, the filaments, of course disposed horizontally, give the plant a bristly appearance by again throwing out erect patent ramuli."

var. **ornithocephala.** *Hassall Alg. t.* 6, *f.* 4.

In dirty green tufts, densely imbricated, and becoming paler. Thallus loosely branched. Oogonia solitary, or in pairs, oval-oblong, obliquely rostrate, beaks truncate, antheridia cylindric-subulate, incurved, interposed, usually exceeding in length the diameter of the oogonia.

Vaucheria ornithocephala, Eng. Fl. v., 320. Harv. Man. 148. Hook. Fl. Scot. ii., 93. Eng. Bot. ii., p. 195. Grev. Alg. Britt. 193. Grev. Fl. Ed. 306. Fl. Devon. ii., 56. Gray Arr. i., 291.

Conferva vesicata, Dillw. Conf. t. 74.

In stagnant or slow-flowing water.

var. **repens.** *Hassall Alg. t.* 6, *f.* 7. *Ann. Nat. Hist.* XI., 430.

Terrestrial. Oogonia single, sessile, oblong or ovate, shortly [redacted]

6. Vaucheria geminata. (*Vauch.*) *Walz. Jahrb. p.* 147, *t.* 12, *f.* 7-11.

Dark or dull green, in dense intricate tufts. Thallus capillary, tough, dichotomous. Oogonia two (rarely 1 or 3), ovate or obovate, opposite, distinctly pedunculate. Antheridia intermediate, subulate, more or less recurved. Mature oospore spotted with brown, sporoderm colourless, composed of three strata. Sporangia on the same or a proper thallus, broadly cup-shaped, truncate, and angularly horned.

SIZE. Oospore ·11-·12 × ·18-·19 mm.

DCand. Fl. Fr. ii., 62. Hass. Alg. t. 3, f. 1. Cleve Vauch. p. 6, f. 4. Kirsch. Alg. Schl. p. 83. Kutz. Tab. Phyc. vi., t. 59, f. 3. Eng. Fl. v., 320. Harv. Man. 148. Eng. Bot. i., t. 1766, ii., t. 2420. Grev. Alg. Britt. p. 193, t. 19. Purton Mid. Fl. ii., 611. Johnst. Fl. Berw. ii., 252. Grev. Fl. Ed. 306. Fl. Devon. ii., 56. Gray Arr. i., 291.

Ectosperma geminata, Vauch. Conf. 29, t. 2, f. 5.

Vaucheria Dillwyni, Rabh. Alg. Sachs. No. 1078.

To this species we also refer the following as synonyms, although usually referred to *V. sessilis*:—

Vaucheria ovoidea, Hass. Alg. 57, t. 5, f. 3.

Vaucheria ovata, Gray Arr. i., 289.

Ectosperma ovoidea, Huds. Fl. Ang. 954. Hook. Fl. Scot. 979. With. Arr. iv., 129.

In ponds and ditches.

var. β **racemosa.**

Oogonia shortly pedunculate, 3 to 5 or more aggregated in a corymbose manner. Antheridia single, scarcely longer than the oogonia.

SIZE. Oospore ·06-·08 × ·075-·08 mm.

Vaucheria racemosa, Eng. Bot. ii., 126. Grev. Alg. Britt. 195. Harv. Man. 149. Grev. Fl. Ed. 306. Gray Arr. i., 292. Hass. Alg. 56, t. 3, f. 2.

We have reproduced Hassall's figure of this form in which the antheridium is considerably longer than the oogonia. Vaucher says, "This species is one of the most common, and is found in nearly all ditches, principally in the spring. It is loaded with little bouquets manifest to the unassisted sight, and which with the microscope seem to be formed of a common peduncle, subdivided into pedicels, each of which carries on its summit a spherical body in every way resembling the grains of other ectosperms, but nearly half as small again. In the middle of this bouquet is the horn, which, without doubt, performs the function of a male flower, and which is here but a prolongation of the peduncle. The number of grains varies from 5 to 7, but commonly 4 are met with."

It is of this species that Hassall says, "It is most frequently infested with the curious parasite *Cyclops lupula* of Muller, which occasions the growth on the filaments of such extraordinary-looking appendages, in the midst of which the parasite resides." This parasite, whatever it may be, was the subject of a communication by Mr. A. Lister to the Essex Field Club, July 22, 1882, and will be found in the "Proceedings" of the Club (Vol. iii.).

Plate XLVIII., figs. 6.7. Oogonia and antheridia of *V. geminata* × 200. Fig. 8, non-sexual spores of the same × 200, after Walz. Fig. 9, mature oospore × 200.

Plate {*XLIX., fig.* 4, fruiting branch of the variety *racemosa*, after Hassall.

7. Vaucheria hamata. (*Vauch.*) *Walz. p.* 148, *t.* XII. *f.* 12-17.

Aquatic or terrestrial, thallus rather rigid, vaguely branched. Oogonia usually single, ovate or ovate-hemisphærical, seated on a short segment of the divided stem, the other segment elongated, curved, forming the antheridium. Mature oospores involved in a sporoderm formed of four or more strata.

Cleve Vauch. p. 6. Hassall Alg. t. v., f. 1. Gray Arr. i., 289.

Ectosperma hamata, Vauch. Conf. 26, t. 2, f. 2. Hass. Ann. Nat. Hist. xi., p. 439.

Vaucheria hamulata, Kutz. Tab. Phyc. vi., t. 61, f. 2.

In ditches.

Vaucher wrote of this species—" It differs from all others by the manner in which it carries its grains. The peduncles which sustain them are much elongated, and they bear at their extremity two little threads, the one is recurved and receives the anther, the other is shorter and straighter, and carries the grain."

Plate XLVIII., figs. 10, 11. Oogonia and antheridia of *V. hamata* × 200. Figs. 12, 13, mature oospores free from oogonia × 200. Fig. 14, sporangium × 200.

8. Vaucheria terrestris. *Lyngb. Hydro. Dan. p.* 77, *t.* 21, *f.* A.

Densely interwoven in a thin bright emerald stratum. Oogonia usually single, pedunculate, attached by the flattened base at the back of the incumbent elongated curved antheridium. Mature oospores enclosed in a hyaline colourless sporo-

Order IV. *NEMATOPHYCEÆ.*

Multicellular algæ, chlorophyllose, membranaceous or filamentous, with or without branches. Vegetation either terminal, limited or unlimited, forming an articulate thread, or in the beginning terminal, and afterwards lateral, forming a membranaceous thallus of a single stratum. Cell multiplication by repeated division in one or two directions.

Propagation by oospores, or by zoogonidia.

Divided into the following families :—

A. Vegetation by division of the cells at first in one, and afterwards in two directions, forming a membranaceous thallus.

Family I. Ulvaceæ.—Thallus membranaceous formed of one stratum of cells, either plane or expanded, or tubular, or saccate.

B. Vegetation by division of the cells in one direction, forming a cellular series or articulate thread.

Family II.—Sphæropleæ.—Articulate thread not branched, articulations greatly elongated, cylindrical, multilocular, chlorophyll mass distributed in ring-like bands.

Propagation by resting spores, which, before germination, break up into zoospores.

Family III. Confervaceæ.—Articulate thread, simple or branched, vegetative articulations cylindrical, fructiferous always more or less swollen. Chlorophyllose mass effused, or parietal, often more or less regularly spiral.

Propagation by macro- and micro-gonidia.

Family IV. Pithophoraceæ.—Cladophora-like plants, with terminal vegetation. Articulate threads branched.

Propagation by neutral, quiescent, cask-shaped spores (agamo-hypnospores).

Family V. Œdogoniaceæ.—Articulate thread either branched or not branched ; articulations short.

Propagation by oospores after sexual fecundation.

Family VI. Ulotricheæ.—Articulate thread not branched, sometimes laterally connate; articulations short, at times very short.

Propagation by macro- and micro-gonidia.

Family VII. Chroolepidæ.—Aërial algæ. Articulate thread branched, cell membrane firm, filled with an equally distributed oleaginous golden or reddish endochrome.

Propagation by zoogonidia.

Family VIII. Chætophoreæ.—Aquatic algæ. Articulate thread dichotomously branched, ramuli sometimes aggregated in a fasciculate or penicellate manner. Chlorophyllose mass usually collected in transverse bands.

Propagation by zoogonidia.—*Rabh. Alg. Eur.* III, 286.

Family I. ULVACEÆ.

Thallus membranaceous, or foliaceous, rarely crustaceous, formed of one stratum of cells, either expanded, or tubulose, or vesiculose.

Propagation by zoogonidia, arising from a repeated division of the cytioplasm. Zoogonidia oblong, furnished at one extremity with two or four cilia.

Sub-Family 1. Prasioleæ.

Thallus expanded and foliaceous, rarely crustaceous.

Genus 54. **PRASIOLA.** *Ag.* (1821.)

Thallus membranaceous foliaceous, ascending or erect, more or less crispate, composed of angular cells, distributed in plane areas ; base sometimes loosely fibrillose.

Vegetation by division of the cells in two directions.

Prasiola crispa. *Kutz. Tab. Phyc. V. t.* 40, *f.* 6.

Tufts more or less dense, often long and widely expanded, dark green, soft and elastic. Thallus plicate crisped, of variable form and size, often bullate ; cells arranged in distinct areolas, or confluent, quadrate, or oblong-quadrangular, now and then twice as long as the diameter; angles more or less obtusely rounded.

Size. Cells ·005-·009 mm. diam., or ·008-·013 mm. × ·003-·005 mm.

[redacted]

and folded. Quaternate granules beautifully arranged in squares, contained in larger ones, and separated by parallel pellucid lines, the whole compared by Agardh to the walks and parterres of a garden. Annual. Found throughout the winter and early spring.—*Eng. Bot. p.* 111.

Plate L. fig. 1. Plants slightly magnified. Fig. 2, portion of a frond × 400.

Prasiola furfuracea. *Menegh. Cenni. p.* 36.

Forming a furfuraceous stratum, more or less expanded, dark green. Thallus about a line long and broad, dilated from the short stem-like base into a fan-like lamina; margin slightly undulate and repand, often emarginate at the apex or lobed. Cells angular, arranged in regular quadrate, or almost quadrate areolas.

Size. Cells ·014-·016 × ·004-·006 mm.

Jessen, Mon. Pras. t. 2, f. 1-10. Rabh. Alg. Eur. iii., 309. Lagerstedt Pras. p. 32.

Ulva furfuracea, Grev. Sc. Crypt. Fl. t. 265. Eng. Fl. v., p. 312. Harv. Man. 171. Eng. Bot. ed. ii., p. 112. Grev. Alg. Britt. 176, t. 18. Mack. Fl. Hib. 244.

On damp walls and rocks.

"Fronds closely tufted, forming a vivid green stratum, a yard or more in extent, two or three lines in length, erect, obovate, truncated, and usually eroded at the top, tapering at the base into a longish claw; margin inflected, substance firm, and void of lubricity. Cells in fours. It does not adhere to paper."—*Carm.*

Plate L. fig. 5. Fronds slightly magnified. Fig. 6, young frond × 400. Fig. 7, lower portion of mature frond × 400.

Prasiola stipitata. *Suhr. in Jessen Mon. t.* 2, *f.* 11-16.

Stratum cæspitose, expanded, dark green. Thallus of variable form and size, commonly one to two lines, rarely four lines long; dilated upwards from a stem-like base (lanceolate, obovate, obcordate, reniform, flabelliform, &c.), often truncate at the apex; margin slightly repand; cells in the stem-like base in series, in the upper part disposed in small regular areolas.

Size. Cells ·005-·007 mm.

Jessen, Prasiola p. 16, t. 2. Rabh. Alg. Eur. iii., 309. Lagerstedt. Pras. p. 36, fig. 4.

On rocks by the sea, &c.

Jessen, in his monograph of this genus, gives figures of the fronds of some Irish specimens of the above species, which he had seen and examined. It is, on the faith of this, included here, although it appears to be the most marine of any of the four.

Plate L. figs. 8. 9. Fronds of *P. stipitata* magnified 4 diam. Fig. 10, young frond × 400. Fig. 11, part of mature frond × 400. All after Jessen.

Prasiola calophylla. *(Spreng.) Menegh. Cenni. p.* 36.

Cæspitose, dark green, crispate; thallus 2-4 lines long, narrow, linear, rather circinate, attenuated at the base into a stem, truncate at the apex, now and then crenate; cells large, arranged in longitudinal series.

SIZE. Cells ·004-·005 × ·002-·004 mm.

Jessen, Mon. Pras. t. 1, f. 1-3. Lagerstedt. Pras. p. 40.

Ulva calophylla, Hass. Alg. 298, t. 77, f. 1. Eng. Fl. v., 312. Grev. Alg. Britt. p. 176. Eng. Bot. ed. ii., p. 112. Harv. Man. 171. Johnst. Fl. Berw. ii., 251. Mack. Hib. 243.

Bangia calophylla, Carm. in Grev. S. Crypt. Fl. t. 220.

On damp stones, rocks, &c.

"Forms a bright green thin stratum. Frond minute, three or four lines long, linear strap-shaped, obtuse, tapering at the base, or suddenly contracted into a cylindrical stipes, much waved and curled, very variable in breadth. Granules quaternate, closely covering the frond; set in longitudinal rows, of which two or more (sometimes half a dozen) form the breadth of the frond; interstices colourless."—*Harvey.*

Plate L. fig. 3. Plant magnified slightly. Fig. 4, lower portion of frond × 400.

Sub-Family 2. ULVEÆ.

Thallus membranaceous, vesiculose, or tubulose.

GENUS 55. **ENTEROMORPHA.** *Link.* (1820.)

Thallus membranaceous, tubular or utricle-shaped, fixed at the base (usually at the first, but afterwards often free swimming); composed of one stratum of cells, sometimes [redacted]

Scot. ii., 91. Johnst. Fl. Berw. ii., 249. Hull, Br. Fl. 311. Abbot Fl. Bedf. 273. With. Arr. iv., 125.

Scytosiphon intestinalis. Gray, Arr. i., 345.

Enteromorpha lacustris. Hass. Trans. Linn. Soc.

Fistularia intestinalis. Grev. Fl. Edin. 300. Fl. Devon. ii., 57.

In ditches, chiefly in brackish water.

This exceedingly variable species has many forms or varieties to which names have been given, one of which by rupture of the apex, is funnel-shaped (var. *Cornucopiæ*), others are more or less thread-like, and others inflated and bullate. Root a minute scutate disc. Frond from a few inches to one or more feet in length, and from a line to three or four inches, or more, in diameter; tubular, obtuse, tapering at base to little more than the diameter of hog's bristle, gradually becoming inflated upwards, and in old age often swelling out into a large membranous bag, which is variously cusped and curled. Sometimes the whole frond is compressed and very much crisped ; substance thin and membranous, but not gelatinous, not closely adhering to paper in drying. Colour varying from a transparent yellowish green to a dull grass green; in old age and decay fading to a dirty white. Under the microscope a portion of the frond exhibits the appearance of a transparent membrane covered with green unequal angular cells.—*Harvey.*

It occurs on the sea shore, in tidal rivers, and ditches connected with them, whether salt, brackish, or fresh water, sometimes at a considerable distance from the sea. In this respect it differs from *Enteromorpha compressa*, which is *not* found in fresh water, and has therefore no claim to be inserted in the present work.

Plate LI. figs. 1, 2. Small fronds of *Ent. intestinalis*, natural size. Fig. 3, the variety *Cornucopiæ*, nat. size. Fig. 4, cells × 400. Fig. 5, zoogonidia.

GENUS 56. **MONOSTROMA.** *Thur.* (1854.)

Frond plane or saccate, simple or torn and lobate, composed of one stratum of cells, cells somewhat rounded (sometimes quaternate) immersed in a homogenous membrane.—*Thuret, Note sur la synonymie des Ulva, &c.*

This genus was formerly included in *Ulva*, from which it was separated by Thuret. See also Monograph of *Monostroma*, by Prof. V. Wittrock. The majority of species are marine.

Monostroma laceratum. *Thur. Note sur Ulv.*

Thallus membranaceous, at length free, thin and flaccid, pallid green, of irregular form, rugose, margin plane and eroded, or crisped (·04-·05 mm. thick) ; cells rounded, twin, ternate, or quaternate, disposed loosely in the intercellular substance, in transverse section of the thallus oval (·017-·023 mm. high), chlorophyllose body central, of the same form as the cell, of which it occupies about one-half.—*Wittr. Mon. Monostr.*, p. 30, *t.* 1, *f.* 2.

Plate LI., fig. 6. Portion of frond × 200. Fig. 7, section of frond × 200 diam.

Monostroma Wittrockii. *Born. Notes Alg. p.* 176.

Thallus membranaceous, gelatinous, bright green (18 mill.) oblong, pedicellate, at first saccate, then open at the summit, margin becoming irregularly lobed. The adult plant becomes sessile, and is attached by a part of its surface, when mature the fronds are large (8 cent. diam.), the lobes plicate, elongated and rounded, cell angular, subquaternate, in section of thallus rounded, chlorophyllose body occupying about half the cell.

In salt or brackish water.

Perhaps hardly claiming a place in this work, as it is more truly a marine species.

Plate LI., fig. 8. Portion of a frond × 200. Fig. 9, 10, sections of frond × 200. Fig. 11, zoogonidia × 300. Fig. 12, germinating × 200, after Bornet.

Monostroma bullosum. Wittr. Mon., p. 28, is the *Tetraspora bullosa* of this work, see *p.* 16, *plate* VI., *fig.* 1.

FAMILY II. SPHÆROPLEACEÆ.

Threads simple, with terminal vegetation, very long, articulate, articulations cylindrical, by spurious septa multilocular. Chlorophyllose mass distributed in annular bands, which enclose from 3-7 starch vesicles.

Propagation by oospores after sexual fecundation, very numerous in the cells, at first green, then red, enclosed in a stellate sporoderm.

GENUS 57. SPHÆROPLEA. *Ag.* (1824.)

[redacted]

"The zoospores are of an elegant shape, but this is not more uniform than their size or colour. Usually they are globular or shortly cylindrical bodies, from one 190th to one 150th of a line long, of a beautiful cinnabar or carmine red, and furnished at one of their ends with a small colourless bead bearing two long cilia. Some of them are larger, pyriform or fusiform, and the result probably of the undivided contents of a resting-spore. Some of the zoospores are two-coloured —red towards the beak, and green throughout the other part, or the two colours are variously disposed, the colourless bead or beak, and the two cilia are invariably very distinct. The zoospores exhibit a slow jerking movement during several hours. This movement is often interrupted for several hours, when the whirling suddenly recommences. When the zoospores break through the integument within which they are formed, they are not enveloped in cellulose, but already during their period of activity they begin to invest themselves with a thin elastic pellicle. At the time of their germination this envelope thickens and lengthens in the form of a spindle, the two ends soon tapering off into long tails, which even the enlarging body of the zoospore itself separates farther and farther apart. The contents of this germ-cell, at first homogeneous and finally granular, change during this first growth. What is left of the red oil is quickly transformed into chlorophyll, and the plantlet assumes a uniform green colour. Nevertheless one may perceive from the beginning a number of vacuoles, or limpid, colourless droplets, in the midst of the protoplasm with which they are filled, and between them the chlorophyll collects in rings more or less distinct from each other. Soon large grains of starch appear in these collections of green matter, so that the plantlet combines all the characteristics of an adult cellule of the *Sphæroplea*, even before it has exceeded a 13th of a line in length. The terminal tails have been observed after the plantlet was more than half a line long. Growth takes place in the middle, by the successive division of the older rings. The contents of the adult threads presents the most beautiful appearances. It consists of a colourless protoplasm, a green chlorophyll, a watery liquid, and granules of starch; the whole so disposed that the liquid element forms large vacuoles in a row, like the pearls of a necklet, and the diameter of which is nearly as great as that of the thread itself. Often these vacuoles abut on each other, and seem to give birth to partitions. In the spaces between the pairs of vacuoles the green plasma and grains of starch crowd together, though the space is disjointed by the innumerable small vacuoles they throw off.

"On approaching fructification the vacuoles multiply to such an extent as to give the endochrome the appearance of a frothy mass, in which the starch granules are irregularly scattered. Soon after the starch granules assemble in pairs or threes or larger numbers, and around these groups the green plasma becomes more plentiful, so that in time they appear as so many equidistant cysts in the axis of the thread. The greater part of the vacuoles having gradually disappeared, the green clots assume a stellate appearance, connected by green mucous rays or filaments. Between these star-like clots large vacuoles are formed in pairs, which flatten so as to look like partitions, so that each thread seems to be divided into numerous compartments.

"The green matter contained in these compartments then undergoes modifications, and the mucous rays are gradually resorbed, the chlorophyll contracting meanwhile—sometimes to the right and sometimes to the left. In a short time the colourless plasm collects around the chlorophyll in such a manner that the partitions disappear, and the whole contents of the thread breaks up into a large number of free globular masses, easily distinguished from the ambient colourless mucilage, and containing a certain quantity of irregularly distributed chlorophyll. These

are the young spores, which undergo a marvellous variety of transformations. At first they are contiguous, but as they contract they become free, though variable in shape, and with their chlorophyll distributed in a thousand different ways. Finally they become spherical and almost completely filled with chlorophyll interspersed with some starch granules, and covered with a thin, smooth layer of plastic matter, but not with a cellulose membrane.

"Long before the foregoing process has taken place, the cell-wall proper of the thread has undergone some peculiar chemical alterations, all tending to its final dissolution to free the fully-developed spores. Previous to this, however, little apertures are formed in it at certain points, varying in diameter from one 500th to one 300th of a line.

"All the cellules of the same filament do not undergo the modifications described. In a large number of them the phenomena are quite different, the green rings, interspersed with colourless vacuoles, gradually change to a reddish yellow, and the grains of starch disappear. Soon the coloured matter thus formed becomes granular, and is finally broken up into innumerable rod-like corpuscles."

Thus the cycle is completed, and we need not pursue the abstract further. *Plate LII.* will serve to illustrate the various changes.

Sphæroplea annulina. (*Roth.*) *Ag. Syst. p.* 76.

Green, yellowish, brick-red, or scarlet, cells 8 to 10 or 20 times as long as broad, with 20 to 30 chlorophyllose rings in each cell; spores at length densely seriate, rarely disposed irregularly, at first green, afterwards olive-brown, and then red.

SIZE. Threads ·036-·07 mm. diam., oospore ·018-·036 mm.

Rabh. Alg. Eur. iii., p. 318. Rabh. Alg. ex. 309, 455, 147. Cohn, in Acad. Berl. 1855, p. 335. Ann. des. Sci. Nat. 4 ser. (1856) v., t. 12-13. Cienkowski, Bot. Zeit. (1855), p. 777. Fresenius Bot. Zeit (1851), p. 241. Braun, Rejuvenescence p. 164, 271, 281.

[redacted]

Family III. CONFERVACEÆ.

Threads articulate, either simple or branched, vegetation terminal, unlimited. Articulations more or less elongated, rarely abbreviated, now and then shorter than the diameter, cylindrical, rarely swollen. Cell membrane sometimes manifestly lamellose. Chlorophyllose mass granulate, containing starch granules, effused, parietal, or sometimes contracted in the centre of the cell.

Vegetation by the repeated division of the primordial utricle in one direction.

Propagation by zoogonidia.

Genus 58. **MICROSPORA.** *Thur.* (1851.)

Articulate thread simple. Chlorophyllose mass at first parietal, afterwards contracted in the centre. All articulations fertile.

Propagation by zoogonidia. Zoogonidia arising from a simultaneous division of the cell contents, small, numerous, ovate-elliptical, cuspidate and colourless at one end, usually furnished with two, rarely 3 to 4, cilia, escaping by rupture of the cell.

Microspora fugacissima. (*Ag. Syst. p* 43.)

Pale green, or yellowish green, articulations before division 4 to 5 times as long as their diameter, after division about 2 to 2½ times as long, not constricted at the joints.

Size. Cells ·0085-·01 mm. diam.

Rabh. Alg. Eur. iii., 321.

Conferva fugacissima, Grev. Fl. Ed. 317. Gray Arr. i., 310. Kirsch. Alg. Schl. p. 80.

In ditches.

Plate LIII. fig. 1. Portions of threads of *M. fugacissima* × 300 diam.

Microspora vulgaris. *Rabh. Alg. Eur.* iii., 321.

Bright green, articulations 2 to 3½ times as long as the diameter.

Size. Threads ·012 mm. diameter.

Conferva bombycina inæqualis, Kutz. Tab. iii., t. 44, f. 3.

Microspora bombycina, Thuret. Rech. p. 12.

Conferva vulgaris, Kirsch. Alg. Schl. p. 79.

In ditches and pools.

Plate LIII. fig 2. Portions of threads of *M. vulgaris* × 300 diam.

Microspora floccosa. (*Ag.*) *Thuret. Rech. t.* 17, *f.* 4-7.

Articulations before division about twice as long as the diameter, after division about equal, or a little shorter, slightly constricted at the joints.

SIZE. Threads ·015-·017 mm. diam. (according to Kirschner ·0075-·01 mm. diam.).

Rabh. Alg. Eur. iii., 321. Thuret. Ann. Sci. Nat. 1850, t. 17, f. 4-5.

Conferva floccosa, Ag. Syst. p. 89. Kutz. Tab. iii., t. 43. f. 3. Eng. Fl. v., 351. Eng. Bot. ii., t. 2474. Harv. Man. 126. Mack. Hib. 224. Gray Arr. i., 310. Kirsch. Alg. Schl. p. 79.

Lyngbya floccosa, Hass. Alg. 223, t. 60, f. 1-2. Jenner, Tunb. Wells, 188.

Conferva fugacissima, Dill. Conf. Supp. t. B.

In stagnant water.

Plate LIII. fig. 3. *a, b*, portions of threads × 300; *c*, cells divided across for the escape of zoogonidia × 300; *d*, zoogonidia.

GENUS 59. **CONFERVA.** (*Linn.*) *Link.* (1820.)

Articulate threads simple, articulations cylindrical. Chlorophyllose mass homogeneous or granulate, including starch granules.

Vegetation by division in one direction.

Propagation unknown, (? by resting-spores which subsequently produce zoogonidia).

Recently Wille has declared his belief in the universality of resting-spores in the whole genus *Conferva*,* although it is hardly clear what

other, and covering it like the lid of a box. Afterwards, through the expansion of the inner membrane, the smaller piece of the outer membrane gives way, and the inner membrane grows through the aperture thus formed in the form of a tube. The development was not followed further, but the writer considers it probable that zoospores are first formed from the resting spores."

In *Conferva bombycina*, var. *minor*, either single cells swell up into a barrel shape, or here and there the contiguous ends of two neighbouring cells assume a club-like form. It is here that the largest part of the Chlorophyllaceous protoplasm accumulates, and after this the swollen end is separated by a transverse wall from the longer narrow part of the mother-cell. The wall of the swollen part thickens later. The author considers these cells to be resting-spores, although he was not able to observe their germination. *Conferva bombycina* var. *genuina* has similar resting-spores.

Three modes of formation of resting-spores of *Confervaceæ* have been observed—(1) by rejuvenescence, and the formation of a new membrane round the contracting contents; (2) by the thickening of the membrane of the mother-cell; (3) by separation of a portion of the cell substance to a swollen part of the mother-cell, and the thickening of the membrane of this portion.

Conferva fontinalis. *Berk. Glean. t.* 14, *f.* 1.

Bright green, attached; articulations 6 to 10 times as long as the diameter, slightly swollen, a little constricted at the joints, starch granules single, scattered or seriate, cell-membrane rather thick, homogeneous, when heated with sulphuric acid swelling and distinctly lamellose.

SIZE. Threads ·016-·018 mm. diam.

Kutz. Tab. iii., t. 45, f. 4. Rabh. Alg. Eur. iii., 323. Kirsch. Alg. Schl. p. 78.

Attached to grass, &c., in ditches.

"It covers rushes, grass, &c., with a short downy green coat, which is very conspicuous in spring and summer."—*Berkeley*.

Plate LIII. fig. 6. Threads of *C. fontinalis* × 150. Fig. 7, portions of threads × 400.

Conferva tenerrima. *Kutz. Tab.* III., *t.* 42, *f.* 1.

Usually pale green, articulations 1½-3 times as long as the diameter.

SIZE. Threads ·0035-·004 mm. diam. (·003-·005 mm. Kirschner).

Rabh. Alg. Eur. iii., 322. Kirsch. Alg. Schl. p. 78.

In fresh water, often mixed with other Algæ.

Plate LIII., fig, 5. Portions of threads of *C. tenerrima* × 400.

Conferva bombycina. *Ag. Syst. p.* 83.

Yellowish green or green, soft, silky; articulations oblong-cylindrical, slightly constricted at the joints, before division three times as long as the diameter, collapsing alternately when dry.

SIZE. Threads ·006-·012 mm. diam.

Rabh. Alg. Eur. iii., 323. Kutz. Tab. iii., t. 44, f. 1, 2. Eng. Fl. v., p. 351. Eng. Bot. ii., p. 159. Harv. Man. 126. Mack. Hib. 224. Kirsch. Alg. Schl. p. 79.

Conferva sordida, Dillw. Conf., t. 60. Johnst. Fl. Berw. ii., 254. Eng. Bot. i., t. 2303. Grev. Fl. Ed. 317. Gray Arr. i., 310.

Vesiculifera bombycina, Jenner Fl. Tunb. Wells, 186.

In ditches, pools, &c., common.

Plate LIII. fig. 4. Portions of threads of *C. bombycina* × 400.

GENUS 60. **CHÆTOMORPHA.** *Kutz.* (1845.)

Articulate thread simple, nearly equally thick, fixed by a discoid, or root-like divided base, lower articulations always short, before division equal, or half as long again as the diameter, after division shorter than the diameter, upper articulations more or less elongated. Cell-membrane thick, firm, sub-cartilaginous, manifestly lamellose. Cell contents green, becoming by age parietal, continuous, finely granulate, containing a few starch granules.

Propagation by zoogonidia.

Chiefly marine, a few in brackish water.

The lamination of the cell walls in this genus, and in *Cladophora*, appeared to Braun to present some analogy to the rings in vascular stems. He says, "The great number of layers which may be distinguished by suitable treatment in the cell membrane, even of plants of short life (*Cladophora*, *Botrydium*, &c.), is not opposed to the assumption that they are *diurnal layers*, and it is imaginable, under this [redacted]

chrome, and about once and a-half as long as broad, and here and there, at irregular intervals, two proximate articulations, longer and broader than the rest, form together a spindle-shaped swelling, in which a dark-coloured endochrome collects, the mass being darkest and densest where the two cells touch each other. This looks like the commencement of fructification, but I am unable to say whether a sporangium is ultimately formed. These dark-coloured double cells are frequently so numerous that they give the filaments, when examined with a pocket lens, a variegated appearance. Substance membranaceous, and in drying the plant scarcely adheres to paper."—*Harvey*.

Plate LIV. fig. 1. Portion of thread of *Chætomorpha litorea* × 100 diam.

Chætomorpha linum. (*Roth.*) *Kutz. Tab.* III., *t.* 55, *f.* 3.

Rather rigid, dark green, or now and then yellowish green and less rigid, lower articulations equal or almost equal in length to their diameter, upper articulations, before division, two or three times as long as the diameter, or even four times, here and there swollen. Cell-membrane of the lower articulations thick, distinctly lamellose, the upper ones thinner and indistinctly lamellose, contracted at the joints.

SIZE. Threads ·25 mm. thick.

Rabh. Alg. Eur. iii., 327. Harv. Phyc. Britt., t. 150, f. A.

Conferva linum, Ag. Syst. 97. Eng. Bot. ii., t. 2363.

Conferva capillaris, Huds. Fl. Ang., p. 598. Lightf. Fl. Scot. 988. Dillw. Conf., t. 9.

Conferva crassa, Eng. Fl. v., 252. Mack. Fl. Heb. 225.

In brackish and salt water.

"Filaments from a few inches to several feet in length, twice as thick as a hog's bristle, very much curled, rigid, crisp, and brittle, soon becoming flaccid if exposed to the air ; lying in thick but not dense bundles, of considerable length, disposed in strata, one above the other. Articulations about as long as broad, filled with granular fluid, which in some joints is more dense than in others. Eventually the joints divide in the centre by a transverse line, and the mass separates, a new diaphragm is then gradually formed, and finally a new joint. This species varies much in colour, being sometimes of a pale, at other times a dark green, and is very often mottled with dark and light green. Substance rigid-membraneous, scarcely adhering to paper in drying."—*Harvey*.

Plate LIV. fig. 2. Portion of sterile thread of *Chætomorpha linum* × 100. Fig. 3, portion of fertile thread with zoogonidia × 100. Fig. 4, zoogonidia × 300.

Chætomorpha sutoria. (*Berk.*)

Dark green, crispate, rather rigid, interwoven in lax tufts, articulations one and a-half times as long as broad, after division shorter than the diameter, cell-membrane thick, distinctly lamellose.

SIZE. Threads ·01-·012 mm. diam.

Conferva sutoria, Berk. Glean., t. 14, f. 3. Harv. Man. 128. Phyc. Britt., t. 150, f. B.

In brackish ditches, estuaries, and salt water.

"Filaments several inches to a foot or more in length, as thick as hog's bristle, variously curved and twisted, forming extensive, loosely packed bundles or strata which fill the pools in which they grow. Articulations once and a-half as long as broad, filled with a dark green fluid, at length separating by a transverse medial line into two portions, which eventually become separate joints. Colour dark green, not variegated. Substance rigid, not adhering to paper in drying."—*Harvey.*

Plate LIV. fig. 5. Portion of base of thread of *Chætomorpha sutoria* × 100.

Chætomorpha implexa. (*Dell.*) *Kutz. Tab.* III., *t.* 51, *f.* 3.

Pale or deep yellowish green, crispate, interwoven in lax tufts, rather rigid, sometimes mucous, articulations before division twice as long as the diameter ; cell-membrane rather thick, indistinctly lamellose, after application of concentrated sulphuric acid at first homogeneous, but after four hours' action manifestly striate-lamellose.

SIZE. Threads, ·04-·06 mm. diam.

Rabh. Alg. Eur. iii., 329.

Conferva implexa, Dillw. Conf., t. B. Ag. Syst. p. 91.

Conferva sutoria, Crouan, Fl. Fin.

In brackish and salt water.

"Filaments forming densely interwoven strata, or tufts among the branches of other Algæ. Joints even in the same thread varying from a little shorter than their breadth to about once and a-half as long. Colour a dark grass green."—*Harvey.*

Plate LIV. fig. 6. Portions of threads of *Chætomorpha implexa* × 200.

GENUS 61. **RHIZOCLONIUM.** *Kutz.* (1843.)

Articulate thread the same as in *Conferva*, but distinctly [redacted]

which sometimes consists of but a few empty cells, at other times lengthens out into a branch. Cells in the same fleece very various, and even in the same filament at different ages; the full-grown cell seems to be fully six times as long as its diameter; but short cells once and a-half to twice as long as broad, which seem to be cells in process of development, are commonly mixed with the long cells. All contain a granular endochrome, the grains of very unequal size."—*Harvey.*

Plate LIV. fig. 7. Portions of thread of *Rhizoclonium Casparyi* × 200 diam.

Rhizoclonium flavicans. *Jurg. Alg.*

Threads soft, simple, extremely fine, matted, somewhat crisped, at first uniform pale green, at length distinctly jointed; articulations once and a-half as long as broad, dotted; interstices pellucid.

SIZE. Threads ·018 mm. diam.

Rabh. Alg. Eur. iii., 331.

Conferva arenicola, Berk. Glean, t. 13, f. 3. Harv. Man. 128. Harv. Phyc. Britt., t. 354 A.

At the mouths of rivers, and salt marshes.

"Creeping on the sandy margin of pools in a salt marsh periodically flooded, forming a thin, soft, delicate, crisped web of a pale yellow green. Threads extremely slender, flexuous, at first self-coloured, with a few scattered dots, then with manifest dissepiments, and finally the granules contract and form a distinctly defined mass of a darker green in the centre, with pellucid interstices. Articulations one and a half times as long as broad. When dry the articulations are alternately contracted."—*Berkeley.*

Plate LIV. fig. 8. Portions of threads of *Rhizocloninm flavicans* × 200 diam.

GENUS 62. **CLADOPHORA.** *Kutz.* (1843.)

Articulate thread variously branched, cell-membrane usually thick, lamellose; cell contents parietal.

Propagation by zoogonidia, arising from simultaneous and multipartite division of the cell contents, moving actively within the mother-cell, afterwards escaping by a lateral or terminal opening, furnished with 2 or 4 vibratile cilia, afterwards germinating without fecundation.

Many species are entirely marine, but some are fresh water. All are disposed to considerable variation, and numerous varieties are named in connection with each of the fresh water species. The following arrangement of the species from Rabenhorst's Algæ will be useful in their identification:—

I. Threads collected in tufts, more or less lax or intricate.
  A. Tufts at first attached, afterwards free swimming.
    a. Cell contents not spirally disposed.
      † Fruiting cells not terminal.
        * Cell-membrane even . . . . *fracta.*
        ** Cell-membrane plicato-striate . . *crispata.*

B. Tufts for the whole life attached.
a. Cell contents disposed in lax spirals.
† Fruiting cells terminal or subterminal.
* Cell-membrane even.
0. Branches connate at the base . . . . *canalicularis.*
00. Branches not connate at the base . . . . . *glomerata.*
** Cell-membrane plicate . . . . *flavescens.*
II. Threads radiating from a common centre, aggregated in a more or less spongy globe . . . . *ægagropila:*

Cladophora fracta. (*Dillw.*) *Kutz. Sp. Alg., p.* 410.

Branches and branchlets sparse, divaricate, here and there refracted, often secund, the lower laterally inserted. Cell contents of the branches not spirally arranged, cell-membrane now and then very thick. Fructiferous cells not terminal, often in the middle of the branches or at their base.

SIZE. Threads ·1 mm. diam.

Kutz. Tab. iii., t. 50. Rabh. Alg. Eur. iii., 334. Jenner Fl. Tunb. Wells 186. Harv. Man. 134.

Conferva fracta, Eng. Fl. v. 356. Johns. Fl. Berw. ii., 254. Eng. Bot. i., t. 2338, ii., t. 2492. Dillw. Conf., t. 14. Lyngb. Hydr. Dan. t., 52. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Mack Hib. 227. Fl. Devon ii., 52. Gray Arr. i., 304.

Conferva vagabunda, Huds. Fl. Ang. ii., 601. Lightf. Fl. Scot. 990. With Arr. iv., 139.

Conferva marina trichoides, lanæ instar expansa, Ray. Syn. 60. Dillen. Musc. 30, t. 5, f. 32.

Cladophora crispata, Hass. Alg. 216.

In fresh and brackish water.

[redacted]

Cladophora crispata. (*Roth.*) *Kutz. Tab* IV., *t.* 40, *f.* 1.

Less coloured than the preceding, now and then dark green, sometimes colourless; branches and branchlets remote, sometimes secund, insertion (at least of the lower branches) apical, articulations collapsing, cell contents (at least of the upper branches) disposed in a lax spiral. Cell-membrane delicately plicate-striate.

SIZE. Primary branches ·022 mm. thick, ultimate branches less than half that diameter, main thread ·12 mm. diam.

Rabh. Alg. Eur. iii., 337.

Conferva crispata, Dillw. Conf. t. 93. Eng. Fl. v., 356. Eng. Bot. i., t. 2350. Harv. Man. 133. Gray Arr. i., 304. Eng. Bot. ii., t. 2420.

In pools.

"Filaments about a foot long, or more, densely entangled, rather tough, destitute of gloss, curled and crisped, especially when old. Articulations 4 or 5 times as long as broad; by drying they become elliptical and compressed alternately."

Plate LV. fig. 3. Upper portion of filament of *Cladophora crispata* × 10. Fig. 4, small portion of sterile thread × 100 diam.

Cladophora glomerata. (*Linn.*) *Kutz. Tab. Phyc.* IV.

Branches in the upper part of the primary thread, and branchlets of the second and third order, usually fasciculate or penicellate. The cell contents of the larger cells applied in a net-like or somewhat spiral manner to the walls. Fructiferous cells always terminal, with the lower cells sterile.

SIZE. Primary and secondary branches to ·06 mm. diam. 3 to 6 times as long.

Rabh. Alg. Eur. iii., 339. Jenner Fl. Tunb. Wells 186.

Conferva glomerata, Linn. Eng. Fl. v., 306. Lightf. Fl. Scot. 993. Dillw. Conf., t. 13. Huds. Fl. Ang. ii., 602. Eng. Bot. i., t. 2192, ii., t. 2494. Harv. Man. 134. Purt. Mid. Fl. ii., 610. Johnst. Fl. Berw. ii., 255. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Sibth. Ox. 337. Abbot. Fl. Bedf. 375. With Arr. iv., 140. Gray Arr. i., 306. Hass. Alg. 213, t. 56, 57, f. 1-2.

Conferva fontinalis ramosissima glomeratim congesta, Ray Syn. 59. Dillen. Musc. 28, t. 5, f. 31, A. B.

Microspora glomerata, Hass. Ann. Nat. Hist. xi.

In clear streams and rivulets, usually attached to stones.

"The whole plant is of a bright, shining green, very smooth, but not at all viscid or gelatinous to the touch. The principal stems are several inches long, sending out numerous capillary branches, which are variously subdivided, and terminate ultimately in ranges of little short ramuli all

directed one way, which gives the plant a peculiar clustered or tuft-like aspect. Articulations at least five times longer than they are broad." —*Eng. Bot.*

Plate LVI. fig. 1. Portion of apex of thread slightly enlarged. Fig. 2, portion of branch × 100. Fig. 3, tip of branch with zoogonidia × 200 diam. Fig. 4, zoogonidia × 320.

Cladophora flavescens. *Ag. Syst. p.* 112.

Pale yellowish, six inches long, very much branched, fasciculate in a plumose manner, branches patent, ultimate branchlets often rather clavate, patent or incurved, cell-membrane often distinctly plicate, cell contents distributed in a reticulate manner.

SIZE. Diameter of branches ·07-·08 mm., 6-12 times as long.

Cladophora glomerata, v. *flavescens*, Rabh. Alg. Eur. iii., 342.

Cladophora flavida, Kutz. Sp. Alg., p. 402.

Conferva flavescens, Eng. Fl. v., p. 356. Dillw. Conf. Supp., t. E. Harv. Man. 133. Eng. Bot. i., t. 2088; ii., t. 2493; Wyatt Alg. Danm., No. 224. Mack. Hib. 227. Gray Arr. i., 304.

Conferva pinnatula, Dillw. Conf., t. 95.

In ditches or pools of brackish or fresh water.

"This species grows in continuous tufts, which, as they rise to the surface, form extensive floating strata covering the pool. Filaments slender, capillary, tangled together, irregularly branched; the main thread somewhat dichotomous, with widely spreading axils, and often bent in an angular manner first to one side then to the other; the lateral branches alternately divided, patent, with a few distant, scattered, alternate, or secund ramuli. Articulations cylindrical, many times longer than broad, filled with a pale, granular endochrome. Colour when young, a yellowish green, becoming yellower in age, and at last almost golden. When dry it has a silky appearance, and fades in the herbarium to a yellowish white. Substance soft, membranous, but not strongly adhering to paper."—*Harvey*.

In ditches, pools, and other standing water.

Articulations four to eight times as long as their diameter, usually bright green.

Plate LVI. fig. 5. Part of branch of *C. canalicularis* × 100 diam.

Cladophora ægagropila. (*Linn.*) *Kutz. Tab.* III.

Dark green, threads rigid, very much branched, radiating from a common centre, at length agglomerated into a very dense, spongy globe. Ramuli erect, often quite obtuse, articulations sometimes incrassated upwards, cell contents not arranged in spirals, cell-membrane now and then thickened.

SIZE. Branches ·04-·07 diam, 2-4 or even 12 times as long.

Rabh. Alg. Eur. iii., 343.

Conferva ægagropila, Linn. Dillw. Conf., t. 87. Purt. Mid. Fl. iii., p. 175. Eng. Bot. ii., 1377; ii., 2496. Harv. Man. 134. Eng. Fl. v., 357. Huds. Fl. Ang. ii., 604. Mack. Hib. 228. Hull Br. Fl. 332. Hook. Fl. Scot. ii., 82. With. Arr. iv., 141.

Conferva globosa, Phil. Trans. Roy. Soc. xli., 498.

Conferva ægagropilaris, Gray Arr. i., 308.

Cladophora glomerata, Hass. Alg., p. 213 in part.

var. **Brownii** (*Dillw.*).

Rabh. Alg. Eur. iii., 345.

Conferva Brownii, Dillw. Conf. Syn., t. D. Harv. Man. 134. Eng. Fl. v., 356. Wyatt Alg. Dan., No. 225. Mack. Fl. Hib. 228. Eng. Bot. 2879.

"This singular vegetable production is a native of Alpine lakes in many parts of Europe, often lying in great abundance at the bottom of the water, and occasionally only rising and floating on the surface. It has been found in the lakes of the north of England, Wales, Scotland, and the district of Connemara in Ireland, but is generally esteemed rare. In size it varies from that of a small pea to three or four inches in diameter, and its form is always nearly spherical. Internally the larger specimens are hollow, without any nucleus, and when examined their substance is found to consist of innumerable green, pellucid, repeatedly branched filaments, firmly entangled together. The vesicles, when the plant is recently taken from the water, are turgid with fluid, and nearly cylindrical, being slightly swollen towards the apex, where the granular matter of the endochrome seems chiefly collected as a green opaque mass; in the terminal vesicle, however, of each branch it assumes often a dark brown hue and more solidity, probably becoming the medium of reproduction, and escaping in the form of sporules. The elasticity of the balls may be estimated by the fact of their having been used as pen-wipers in the north of England.—*Eng. Bot.* 167.

Plate LVI. fig. 6. Threads of *C. ægagropila*, nat. size. Fig. 7, portion of upper branch × 100 diam.

FAMILY IV. PITHOPHORACEÆ.

Chlorophylliferous Cladophora-like Fresh-water Algæ, consisting of cells formed by bipartition of the terminal cell, the thallus having two distinct parts—(1) the cauloid part, developed from the germinated spore upwards, propagative, and almost always branched, the branches placed a little space below the top of their supporting cells ; (2) the rhizoid part developed from the germinated spore downwards, almost always sterile and branchless, commonly unicellular. Spores neutral, quiescent (agamo-hypnospores), generally cask-shaped, single, formed by division into two of the cauloid cells, of the chlorophyll filled, and commonly widened upper parts of these cells ; in germinating, as a rule, dividing into two cells, the one giving rise to the cauloid and the other to the rhizoid part of the thallus.—*Wittrock, Monograph of the Pithophoraceæ*, p. 46.

For full details of this Family, consult Prof. V. B. Wittrock "On the Development and Systematic Arrangement of the Pithophoraceæ" (published in English). Upsal, 1877.

GENUS 63. **PITHOPHORA.** *Wittr.* (1877.)

Character the same as that of the family given above.

The formation of spores is effected in the following manner:—The [redacted]

The reproduction of individuals may, however, be effected also in another way than by the formation of spores. Besides the specimens which form spores, there are others which never do so. These, which are distinguished by a richer ramification, transform part of their cells into so-called "prolific cells." A common vegetative cell grows richer in chlorophyll coloured protoplasm and starch, and is thus made fit to form a new individual. This the prolific cells do, when they have been made free, by the destruction of the mother specimen, by forming a new specimen laterally near their top, in the same manner as a branch—and later a system of branches—is formed by a cell in the fertile specimens. That the specimens originated by prolific cells have the power of forming spores is certain, as well as that specimens forming prolific cells may have been originated by spores. I do not know with certainty whether specimens forming prolific cells may have been originated by prolific cells themselves, but it seems to me in no wise improbable.—*Wittrock*, l. c.

Pithophora Kewensis.—*Wittr. Mon. p.* 52.

Principal filament of the cauloid part of the thallus, in fertile specimens, on an average ·059 m. thick, with solitary branches of only one degree (rarely of two), spores single, partly enclosed, partly terminal, the enclosed spores cask-shaped, but more elongated, on an average ·08 m. thick and ·2 m. long. the terminal spores cask-shaped, with the upper end conical and the top somewhat rounded, on an average ·088 mm. thick and ·219 mm. long; the rhizoid part of the thallus as a rule unicellular.

Wittr. Mon. Pithoph. t. 1 f. 8, t. 2 f. 1-12; t. 3 f. 1-9; t. 4 f. 2-11; t. 5 f. 9 10.

In tank, Water-lily house, Kew Gardens. August.

This singular plant is thought by Wittrock to have been an importation from Brazil. It has not been seen in its original locality for two or three years.

Plate LVI. fig. 8. Portion of spore-bearing filament × 20. Fig. 9, portion of principal filament with spore formed at the apex of a short branch, and another in process of formation in the principal filament × 200. Fig. 10, a mature enclosed spore × 200. Fig. 11, part of cell from rooting portion of a sterile thread × 200. All after Wittrock.

Family V. ŒDOGONIACEÆ.

Monœcious, or diœcious algæ. Filaments articulated, either simple (*Œdogonium*) or branched (*Bulbochœte*). Basal cell obovate-clavate, mostly lobately divided, or ending in a disc.

Propagation by zoospores, or by oospores after sexual fecundation. The zoospores formed singly in certain cells, broadly oval or globose, transparent at one end, and furnished with a crown of vibratile cilia. Oogonia single or in a chain (2 to 5) contiguous to each other, more or less tumid, with a single oospore in each, becoming reddish brown or yellowish when mature, and then, before germination, dividing into (mostly 4) zoospores.

Male plants, dwarf (nannandrous) and attached to the female plants, or elongated (macrandrous) and similar to the female filaments (often rather thinner). Spermatozoids produced in abbreviated special cells (spermogonia).

Genus 64. **ŒDOGONIUM.** *Link.* (1820.)

Articulated filament simple, at first fixed, afterwards free swimming. Cells marked with transverse striæ at one or other extremity. Terminal cell sometimes elongated and setiform. Either monœcious or diœcious; when diœcious the male plants either dwarf—produced from short cells of the female plants—or elongated and independent.

[redacted]

breaking away of the wall of the mother cell. In this manner the new cell soon attains a length equal to the one from whence it sprung (the successive stages shown on Plate LVII, figs. 1 to 4). When the young cell has matured it becomes in turn a mother cell, the splitting round is repeated, a second streak or cap is carried upwards, and thus as many as four, five, or six successive cells are formed, as indicated by the four, five, or six striæ or caps which may be counted at the apex of a cell. The number of caps corresponding to the number of cells produced in this manner consecutively immediately beneath the caps.

Asexual reproduction takes place by the formation of a single zoospore in one of the cells of the filament (Plate LVII, fig. 15). It is of a globose or somewhat ovate form, furnished near its apex with vibratile cilia (fig. 14). When mature it escapes by rupture or fissure of the mother cell, moves about for awhile, then becomes attached by the ciliated end, and ultimately developes into a young plant.

Sexual reproduction is varied in three ways. In the monœcious species the oogonium is an inflated cell, more or less globose, enclosing a single oospore of similar form. The oogonium is either perforated by a pore, or splits round and opens with a lid or operculum. The same thread bears above or below the oogonium very much shortened cells, in which one or two active spermatozoids are produced. These escape when mature, and fecundate the oospore through the perforation or opening of the oogonium, after which they disappear, and the oospore ripens into a perfect, fertile, resting spore.

In the diœcious species there are two modes of sexual reproduction. In one group of species the males are dwarf, almost might be called antheridia. The oogonia and oospores are the same as in the monœcious species. In like manner there are also abbreviated cells in some other part of the same thread, but these do not produce spermatozoids, but androspores, small active ciliated bodies, which move about for a time, and then attach themselves either upon or near the oogonia, grow into the form of an inverted flask (figs. 8 to 10), being supported by a more or less elongated stem, and constitute the dwarf male (nannandrous) plants, the cells at the apex of which contain the spermatozoids, the upper cell opening by a lid, or cap, to permit of the escape of its contents, which fertilize the oospore as in the previous method.

The second group of diœcious species have male filaments, which in all respects resemble the sterile females, except that they are usually a little thinner. The female filaments produce only the oogonia. The male filaments, in certain abbreviated cells, give origin to the spermatozoids, which in due time escape and fertilize the oospores of the female plants. Thus, in the first group, the dwarf males are generated in certain privileged cells of the female plants, whilst in the second group the male and female filaments are from the first distinct. The former are called *nannandrous* species, the latter *macrandrous.*

The fertilized oospore becomes a resting spore, which ultimately passes through the following stages :—Previous to germination the spore has an egg-shaped figure; the cell contents are densely crowded, and composed of minute brownish-green granules, closely surrounded by a distinct cell-membrane. Outside this membrane there is found besides quite a distinct cell-membrane. Upon germination there are formed in both membranes slit-like openings, whereupon the cell contents emerge, surrounded by an extremely delicate hyaline covering. The cell contents are composed not of one, but usually of four green masses, each surrounded by its cell-membrane. Sometimes also as it appears, abnormally, the masses are two or three in number. The four cells which proceed from germination possess an oval form, and their cell-membrane is hyaline. After the contents of the spore have emerged there remains

behind the outer membrane, enclosing the inner one. After the four cells have remained some time enclosed in the hyaline covering, this becomes resorbed subsequently, and the four cells lie still and motionless, but after the course of a short time the cells burst on one end by means of an annular slit, and the apex, separated thereby from the remainder of the cell-membrane, becomes elevated like a lid. Through the circular opening the cell contents now emerge, which at the part turned towards the opening is colourless. This apex moves with vigorous motion backwards and forwards, and after an hour the cell contents, in the form of a zoospore, leave their place of detention, which we now find to be a doubly-coloured cell-membrane. The little zoospore wheels in a lively manner about with a circling movement, whereby the colourless point becomes directed downwards. Its appearance is like that of an ordinary zoospore, and, like it, possesses an oval form and a lighter apex, furnished with cilia, which during the motion is always directed forwards. After a time the movements become faint, and finally cease. The cilia disappear, and the light end becomes elongated into a root, which sometimes becomes an organ of attachment, quite like that produced in the germination of the ordinary zoospores. The rounded end of the germinating zoospore acquires a little point-like apex. This growth becomes divided by a transverse septum, and a little two-celled Œdogonium has originated. From each spore there are thus derived, in general, four plants.

Plate LVII. figs. 1-5. Stages in the formation of new cells—after Pringsheim. Fig. 6, male cells of *Bulbochæte crassa*, with spermogonia. Fig. 7, zoospore of *Œdogonium*—after Pringsheim. Figs. 8–10, development of dwarf males—after De Bary. Fig. 11, spermogonia. Figs. 12.13, imgregnation of *Œdogonium ciliatum*—after Pringsheim. Fig. 14, zoospore of *Œdogonium rivulare*. Fig. 15, zoospore developing in its mother-cell—after Pringsheim. Fig. 16, zoospore of *Bulbochæte setigera*. Figs. 17-19, segmentation of resting spores of *Œdogonium*. Fig. 20, oospore escaping from oogonium. Fig. 21, mature oospore of *Bulbochæte* undergoing division. Fig. 22, four zoospores developed from the same. Fig. 23, sterile cells of *Œdogonium Reinschii*. All magnified 400 diam.

The following is an arrangement of British species, on the basis of [redacted]

B. *Oogonia furnished with verticellate median processes.*

a. Oospores subglobose.

Œ. Itzigsohnii, *De By.*

b. Oospores subellipsoid.

Œ. excisum, *Wittr. & Lund.*
Œ. Archerianum. *Cke.* (*Pringsheimianum*, Archer).

Sect. 2. Diœcious species.

Sub-Sect. 1. Species with dwarf males.

A. *Species with dwarf males unicellular.*

a. Oogonia furnished with verticellate processes in the middle.

Œ. platygynum, *Wittr.*

b. Oogonia always destitute of median processes.

α Oospores globose or subglobose.

Œ. Rothii, *Le Cl.*
Œ. Areschougii, *Wittr.*
Œ. pluviale, *Nord.*
Œ. undulatum (*Breb.*).
Œ. Reinschii, *Roy.*

β Oospores subellipsoid.

None.

B. *Species bicellular, spermogonia internal, with dwarf males.*

Œ. depressum, *Prings.*

C. *Species with dwarf males bi-multicellular, spermogonia external.*

a. Oospores even.

α Oospores globose or subglobose.

Œ. flavescens, *Hass.*
Œ. Braunii, *Kutz.*
Œ. macrandum, *Wittr.*
Œ. crassiusculum, *Wittr.*

β Oospores ellipsoid or egg-shaped.

Œ. Borisianum, *Le Cl.*
Œ. concatenatum, *Hass.*
Œ. acrosporum, *D. By.*
Œ. ciliatum, *Hass.*

b. Oospores echinulate.

α Oospores globose.

Œ. Cleveanum, *Wittr.*
Œ. echinospermum, *Br.*

β Ooospores ellipsoid.

None.

Sub-Sect. 2. Species diœcious, with elongated male plants.

a. Oospores echinulate.

None.

b. Oospores smooth.

α Oogonia not, or slightly, swollen.

Œ. capillare, *L.*

β Oogonia manifestly tumid.

aa Oospores globose or subglobose.

Œ. calcareum, *Wittr.*
Œ. cardiacum, *Hass.*
Œ. carbonicum, *Wittr.*
Œ. Pringsheimii, *Cram.*
Œ. punctato-striatum, *D. By.*

ββ Oospores ellipsoid or egg-shaped.

Œ. Boscii, *Le Cl.*
Œ. tumidulum, *Kutz.*
Œ. Landsboroughii, *Hass.*
  v. gemelliparum, *Pr.*
Œ. rivulare, *Le Cl.*

Sect. 3. Species of which the organs of fructification are imperfectly known.

a. Oospores globose or subglobose.

Œ. delicatulum. *Kutz.*
Œ. tenellum. *Kutz.*
Œ. hexagonum. *Hass.*
Œ. Londinense. *Wittr.*
Œ. fasciatum. *Kutz.*
Œ. capillaceum. *Kutz.*
Œ. Hutchinsiæ. *Wittr.*
Œ. princeps. *Hass.*

b. Oospores subelliptic or oval.

Œ. longatum. *Kutz.*
Œ. vesicatum. *Lyngb.*
Œ. grande. *Kutz.*
Œ. giganteum. *Kutz.*
Œ. crassum. *Hass.*

[redacted]

SECTION 1. Monœcious species.

A. *Oogonia always destitute of median processes.*

a. Oospores globose or subglobose.

Œdogonium Petri. *Wittr. Mon. Ædog. p.* 6.

Oogonia single, very rarely binate, pear-shaped globose, opening by a pore a little above the middle. Oospores rather depressed globose, almost filling the oogonium; spermogonia 1-2 celled, hypogynous or epigynous; spermatozoids single (?), terminal cell obtuse.

SIZE. Cells ·006-·007 mm., 5-7 times as long; oogonia ·021-·024 mm. × ·022-·029 mm.; oospore ·020-·23 × ·017-·019 mm.; cells of spermogonia ·0055-·006 × ·01-·011 mm.

Kirch. Alg. Schles. p. 51.

Ireland.

Having carefully measured a great number of the species here recorded, and found Wittrock's measurements universally accurate, we have given his dimensions throughout for all the species recorded by him. Unfortunately it is not easy to reduce Rabenhorst's measurements to millemetres, and equally difficult to reconcile them.

Plate LXVIII. fig. 1. *Œdogonium Petri* with oogonia × ·400.

Œdogonium cryptoporum. *Wittr. Dispos. Œd. p.* 19.

Oogonia single, elliptic, or rather depressed globose, opening by a median pore, almost filling the oogonium, spermogonia 2-7 celled, scattered. Spermatozoids single (?).

SIZE. Cells ·007-·009 mm. 4-6 times as long; oogonia ·024-·025 × ·026-·027 mm.; oospore ·022-·023 × ·019-·021 mm.; cells of spermogonium ·006-·008 × ·007-·011 mm.

var. β. **vulgare.** *Wittr.*

Oogonia 2-5, continuous or single, spermogonia 1-4 celled, subepigynous or hypogynous, or scattered.

SIZE. Cells ·005-·008 mm. 3-5 times as long; oogonia ·018-·025 × ·018-·026 mm.; oospore ·016-·022 × ·013-·018 mm.; cells of spermogonium ·005-·007 × ·009-·012 mm.

Kirch. Alg. Schles. p. 52. Wittr. Mon. p. 7.

Britain.

We have only seen the *variety*, from the West of England. The type form has not yet been found in Britain.

Plate LXVIII. fig. 2. *Œdogonium cryptoporum.* var. *vulgare* with oogonia × ·400

Œdogonium curvum. *Prings. Beitr. p 69, t. 5, f. 3.*

Oogonia 2-7 continuous, or single, depressed globose, opening by a median pore; oospores depressed globose, filling the oogonium; spermogonia 3 or many celled, situated in the upper part of the filament; spermatozoids single, the upper part of the thread arcuate, or spirally twisted.

SIZE. Cells ·005-·01 mm. 1½-4 times as long; oogonia ·023-·025 × ·02-·024 mm.; oospore ·02-·023 × ·016-·019 mm.; cells of spermogonium ·007-·009 × ·007-·009 mm.

Wittr. Mon. Œdog p. 8. Kirch. Alg. Schles. p. 52. Rabh. Alg. Eur. iii. 350.

Ireland.

Plate LVIII. fig. 3. *Œdogonium curvum*, with oogonia and spermogonia × 400.

Œdogonium cymatosporum. *Wittr. & Nord. in Wittr. disp. Œdog. p.* 121.

Oogonia single, rarely binate, rather depressedly globose, opening by a pore at the middle, or a little above the middle, nearly filling the oogonium, membrane of the oospore scrobiculate (undulated in a transverse section), pits deep and dense; spermogonia 1-4 celled, somewhat epigynous, hypogynous, or scattered; spermatozoids single.

SIZE. Cells ·008-·01 mm. 4-7 times as long; oogonia ·024-·034 × ·027-·036 mm.; oospore ·022-·031 × ·019-·027 mm.; cells of sperm. ·008-·009 × ·009-·015 mm.

Wittr. Mon. Œdog. p. 8.

Britain.

Plate LVIII. fig. 4. *Œdogonium cymatosporum* with oogonia. *a*

[redacted]

Œdogonium vernale. (*Hass*) *Wittr. Mon. Œdog. p.* 10.

Oogonia single, obversely egg-shaped or globose, opening with an operculum, fissure narrow, oospores globose, not filling the oogonium, spermogonia bicellular, sub-epigynous.

SIZE. Cells ·010-·016 mm. by 4½-6 times as long; oogonia ·339-·045 × ·045-·051 mm.; oospore ·034-·038 × ·034-·039 mm.; sperm. cell ·01-·012 × ·008-·009 mm.

Vesiculifera vernalis Hass. F. W. Alg. p. 434.

Vesiculifera Candollei Hass. F. W. Alg. p. 208, t. 52, f. 9. Rabh. Alg. Eur. iii. 355.

England.

Plate LVIII. fig. 6. *Œdogonium vernale* with oogonia and spermogonia × 400.

Œdogonium crispum. (*Hass*) *Wittr. Mon. Œdog. p.* 10.

Oogonia single, obversely egg-shaped or globose, opening with an operculum, fissure narrow; oospores nearly globose, not filling the oogonium; spermogonia 2-5 celled, hypogynous, or sub-epigynous; spermatozoids binate, terminal cell obtuse.

SIZE. Cells ·012-·018 mm. 2-4½ times as long; oogonia ·037-·049 × ·042-·054 mm.; oospore ·033-·046 × ·034-·046 mm.; sperm. cell ·009-·014 × ·007-·012 mm.

Kirch. Alg. Schles. p. 52.

Versiculifera crispa, Hass. F. W. Alg. 203, t. 52, f. 8.

Œdogonium rostellatum, Prings. Beitr. p. 69, t. 5, f. 1; Archer Quart. Journ. Micr. Sci., 1867, p. 79; Rabh. Alg. Eur. iii, 347.

Œdogonium pulchellum, Braun. Rabh. Alg. Eur. 2095.

Britain and Ireland.

"This is one of several monœcious species, but it is also characterized by the oogonium not opening by a pore or aperture formed in its wall, for the admission of the spermatozoids, as is usual in this genus, but by a circumscissile dehiscence. From the cleft so produced an inner membrane projects, which seems to be itself perforate."—*Archer.*

Plate LVIII. fig. 7. *Œdogonium crispum* with oogonia × 400.

Œdogonium Vaucherii. (*Le Clerc.*) *Braun. Chytr, t.* 2, *f.* 13.

Oogonia single, obversely egg-shaped, or globose, or nearly globose, opening by a pore above the middle; oospores globose or nearly globose, not completely filling the oogonium; spermogonia 2-4 celled, sub-epigynous or hypogynous, spermatozoids binate.

SIZE. Cells ·02-·03 mm. 1½-4 times as long; oogonia ·04-·055 × ·045-·065 mm.; oospore ·035-·05 × ·035-·052 mm.; sperm. cell ·017-·024 × ·006-·011 mm.

Wittr. Mon. Œdog., p. 13. Kirch. Alg. Schles, p. 52. Rabh. Alg. Eur. iii., 349, in part.

Prolifera Vaucherii, Le Clerc sur. Prolif. 474, t. 24, f. 4 ?

Vesiculifera Vaucherii, Hassall, t 50, f. 4.

Britain.

Plate LVIII. fig. 8. *Œdogonium Vaucherii*, with oogonia and spermogonia × 400.

Œdogonium urbicum. *Wittr. Mon. Œdog. p.* 13.

Oogonia single, ellipsoid, opening by a pore above the middle, oospores globose, not filling the oogonium, spermogonia usually 2 celled, spermatozoids binate, supporting cells destitute of chlorophyll.

SIZE. Cells ·016 mm. by $2\frac{1}{2}$, 6 times as long ; oospore ·033-·045 × ·033-·045 mm.

Kirch. Alg. Schles. p. 52.

Œdogonium tumidulum, Prings. Beitr., p. 69, t. 5, f. 2 (not Kutzing). Micr. Journ. 1866, p. 69.

Œdogonium Vaucherii, in Rabh. Alg. Eur. iii., 349, in part.

Ireland.

Plate LIX. fig. 1. *Œdogonium urbicum*, with oogonium and spermogonia × 400.

b. Oospores ellipsoid or egg-shaped.

Œdogonium paludosum. (*Hass.*) *Wittr. Mon. Œdog. p.* 14.

Oogonia single, ellipsoid, usually rather oblique, opening by a pore above the middle ; oospores ellipsoid, distinctly filling the oogonium (membrane of the oospore, when mature, longi-

[redacted]

pore in the fissure, viewed from above stellate, with 7-10 rays, the depressions between the rays deep and rounded; oospores globose, not filling the oogonium; spermogonia 1-2 celled, terminal cell obtuse or apiculate.

SIZE. Cells ·008-·01 mm. by 3-6 times as long; oogonia ·034-·038 × ·032-·04 mm.; oospore ·022-·023 × ·022-·023 mm.; sperm. cell ·008-·009 × ·009-·015 mm.

Wittr. Mon. Œdog. p. 16. Kirch. Alg. Schles. p. 53. Archer, in Quart. Journ. Micr. Sci., 1866, p. 63, Rabh. Alg. Eur. iii., 352.

Ireland, Scotland.

This minute species Mr. Archer had found several times, and often showing its peculiarly-lobed oogonium, but he had never found the male fructification; he believed the plant must turn out to be a diœcious species; he had sometimes noticed a minute notch-like depression on the upper outer margin of the oogonium, probably indicating the "micropyle." He drew attention to the character, not adverted to by De Bary, that the apical or terminal joint of the filament possessed a short acute spine or mucro. This in old plants, frequently is not to be seen, as the terminal joint, or, indeed, considerable portions of the filaments, often become detached, and chiefly in a young condition only are the plants found entire.—*Quart. Journ. l. c.*

Plate LIX. fig. 3. *Œdogonium Itzigsohnii*, with oogonia and oospores; *a*, transverse section of oospore × 400.

b. Oospores subellipsoid.

Œdogonium excisum. *Wittr. & Lund., in Wittr. Œdog. Nov. p.* 3, *t.* 1, *f.* 1-4.

Oogonia single, biconically-oblong, median processes 9, rounded, small, oogonia deeply cut round (circumscissile), vertical view orbicular, margin slightly undulated; oospores ellipsoid, as if constricted in the middle, not filling the oogonium. Spermogonia 1-2 celled, subepigynous or hypogynous, terminal cell obtuse, upper part of the filament curved.

SIZE. Cells ·0035-·005 mm. by 5-6 times as long; Oogonia ·013-·015 × ·018-·025 mm.; oospore ·009-·012 × ·015-·018 mm.; sperm cell ·003-·0035 × ·006-·007 mm.

Wittr. Mon. Œdog. p. 16. Archer, Quart. Journ. Micr. Sci., 1875, xv., p. 102.

Ireland (rare).

Plate LIX. fig. 4. *Œdogonium excisum*, with oogonia; *a*, section of oospore × 400.

Œdogonium Archerianum, *Cooke.*

Monœcious; oospore elliptic, its wall marked by somewhat coarse longitudinal striæ, not filling the cavity of the much

larger and elliptic oogonium; aperture of the oogonium very high up, being quite close to the annular striæ of the caps.

Œdogonium Pringsheimianum, Archer, in Quart. Journ. Micr. Sci., 1868, pp. 295.

Ireland.

There being already a species bearing the name of *Œdogonium Pringsheimii*, which had priority, it became necessary to alter Mr. Archer's specific name. We have *not* seen the species, and hence are unable to furnish a figure. Unfortunately no measurements are given with the above very brief description, which is a doubtful economy of space. It is the only monœcious species with striate elliptical oospores.

SECTION II. Diœcious species.

A. *Dwarf males unicellular.*

a. Oogonia furnished with verticellate median processes.

Œdogonium platygynum. *Wittr. Œdog. Nov. p.* 1.

Gynandrosporous. Oogonia single (very rarely binate), depressedly obverse egg-shaped, median processes 7-12, rounded; oogonia cut round (circumscissile) below the middle, opening by a pore seated in the fissure, vertical view ·orbicular, margin sinuate, with 7-12 (usually 8) depressions; oospores rather depressedly globose, nearly filling the oogonium, androsporangia 1-3 celled; terminal cell obtuse. Dwarf males obverse egg-shaped, small, seated on the oogonia.

SIZE. Cells ·006-·01 mm., from 2-5 times as long; oogonia ·021-·03 × ·016-·024 mm.; oospore ·017-·024 × ·015-·02 mm.; androsp. cell ·006-·008 × ·007-·008 mm.; dwarf males [redacted]

Wittr. Mon. Œdog. p. 18. Kirch. Alg. Schl. p. 53. Rabh. Alg. Eur. iii. 348.
Vesiculifera Rothii, Hassall, t. 53, f. 7 ?
Prolifera Rothii, Le Clerc Prolif. 476, t. 23, f. 8 ?

Scotland, Ireland, England.

Mr. Archer mentions this plant as having been found by him with a chain of as many as eleven oogonia in succession.—*Quart. Micro. Journ.*, 1866, p. 69.

Plate LIX. fig 6. *Œdogonium Rothii* with oogonia, androsporangia, and dwarf males × 400.

Œdogonium Areschougii. *Wittr. Disp. Œdog. p.* 122.

Gynandrosporous. Oogonia 2-6, continuous or single, rather depressedly globose, broadly cut round (circumscissile) in the middle, opening by a pore in the fissure. Oospore exactly globose, not by any means filling the oogonium. Androsporangia 1-6 celled, hypogynous or subepigynous, or rarely scattered, terminal cell (which sometimes is the androsporangium), obtuse, dwarf males obversely egg-shaped, seated on the oogonia.

SIZE. Cells ·008-·012 mm., 4-6 times as long; Oogonia ·038-·039 × ·036-·04 mm.; oospore ·022-·024 × ·022-·024 mm.; androsp. cells ·01-·011 × ·01-·012 mm.; dwarf males ·006-·007 × ·014-·015 mm.

Archer in Quart. Journ. Micr. Sci. 1872, xii., p. 422. Wittr. Mon. Œdog. p. 19.

Ireland.

Plate LIX. fig 7. *Œdogonium Areschougii* with oogonia, androsporangia, and dwarf males × 400—after Wittrock.

Œdogonium pluviale. *Nordst. Rab. Alg. Eur. No.* 2257.

Idio-androsporous. Oogonia simple, rarely 2-3 continuous, obversely egg-shaped, globose, or nearly globose, opening by a terminal operculum, fissure narrow; oospores nearly globose, almost filling the oogonium, terminal cell obtuse, filaments bearing the androsporangia a little slenderer than the female filaments; androsporangia 6-10 celled; dwarf males broadly obverse egg-shaped, seated on the oogonia.

SIZE. Cells ·018-·028 mm., equal to three times as long; oogonia ·034-·039 × ·034-·045 mm.; oospore ·032-·037 × ·031-·04 mm.; androsp. cell ·017-·019 × ·006-·011 mm.; dwarf males ·01 × ·015 mm.

Wittr. Mon. Œdog. p. 19.
Œdogonium diplandrum, Jur. Beitr. Œdog. p. 27, t. 1-3.
Vesiculifera dissiliens, Hass. F. W. Alg. 202, t. 50, f. 7.

Plate LIX. fig. 8. *Œdogonium pluviale* with oogonia and dwarf male × 400.

Œdogonium undulatum. (*Breb.*) *Br. in De Bary Œdog. p.* 94.

Oogonia single or twin, ellipsoid-globose, or nearly globose, opening by a pore below the middle; oospores ellipsoid-globose, or nearly globose, nearly filling the oogonia; vegetative cells four times undulatingly constricted; terminal cell (which sometimes is the oogonium) obtuse; dwarf males obconical, seated on the supporting cells.

SIZE. Cells ·015-·017 mm., 3-5 times as long; oogonia ·051-·056 × ·057-·075 mm.; oospores ·046-·05 × ·048-·06 mm.; dwarf males, ·009-·01 × ·0.

Wittr. Mon. Œdog. p. 20. Kirch. Alg. Schles. p. 54. Rabh. Alg. Eur. iii. 351.

Conferva undulata, Brebisson.

Cymatonema confervaceum, Kutz. Tab. iii., t. 47, f. 1.

Scotland.

Plate LIX. fig. 9. *Œdogonium undulatum* with oogonia and dwarf male × 400.

Œdogonium Reinschii. *Roy MSS.*

Mr. Roy has announced that the *Cymatonema* figured by Reinsch (*Contrib. t.* 6, *f.* 7) has been found in Scotland, and is a genuine *Œdogonium*, but no further details have transpired, and we know nothing of the fructification. The sterile cells are figured on Plate LVII. fig. 23.

B. *Dwarf males bicellular, spermogonia internal.*

Œdogonium depressum. *Prings. Beitr.* 69, *t.* 5, *f.* 5

Gynandrosporous. Oogonia single, depressedly globose, opening by a pore at the middle. Oospores depressedly globose, not filling the oogonia; androsporangia 2-celled; [redacted]

(sometimes rather hexagonally globose), opening by a pore a little above the middle; oospores globose, not filling the oogonia; androsporangia 1-9 celled; dwarf males a little curved, seated on the supporting cell; spermogonia 1 (or 2 ?) celled.

SIZE. Cells ·018-·021 mm. by $4\frac{1}{2}$ to 6 times as long; oogonia ·049-·052 × ·051-·060 mm.; oospore ·045-·049 × ·045-·049 mm.; androsp. cell ·017-·02 × ·008-·018 mm.; sperm. cells ·009-·01 × ·015-·02 mm.

Wittr. Mon. Œdog. p. 21, t. 1, f. 12-14.

Vesiculifera flavescens, Hass. F. W. Alg. 206, t. 53, f. 9.

Plate LX. fig. 2. *Œdogonium flavescens* with single and twin oogonia; *a*, androsporangia × 400.

Œdogonium Braunii. *Kutz. Sp. Alg. p.* 366.

Gynandrosporous. Oogonia single, ellipsoid, globose, opening with a pore at the middle; oospores globose, not filling the oogonia; androsporangia 1-2 celled; dwarf males a little curved, seated about the oogonium, often on the supporting cells; spermogonia 1-celled.

SIZE. Cells ·013-·015 mm., 2-4 times as long; oogonia, ·03-·033 × ·033-·036 mm.; oospore ·027-·029 × ·027-·029 mm.; androsp. cell ·014-·015 × ·011-·012 mm.; sperm. cell ·005 × ·009 mm.

Prings. Beitr. p. 70, t. 5, f. 6. Wittr. Mon. Œdog. p. 22. Kirch. Alg. Schles. p. 55. Archer in Quart. Journ. Micr. Sci. 1866, p. 69. Rabh. Alg. Eur. iii. 349.

Britain, Ireland.

Plate LX fig. 3. *Œdogonium Braunii* with oogonia, oospores, and dwarf males × 400.

Œdogonium macrandum. *Wittr. Disp. Œdog.* 130, *t.* 1, *f.* 3-5.

Oogonia single or twin (rarely three), obversely egg-shaped or globosely egg-shaped, opening by an operculum, with a very narrow fissure; oospores globose or egg-shaped globose, not filling the oogonia; terminal cell very shortly apiculate; dwarf males very much curved, seated on the oogonia (stem sometimes 2-3 celled); spermogonia many (to 7) celled.

SIZE. Cells ·015-·016 mm., 3-5 times as long; oogonia ·036-·04 × ·043-·054 mm.; oospore ·031-·034 × ·033-·039 mm.; sperm. cell ·009 mm.

Wittr. Mon. Œdog. p. 24. Archer Quart. Journ. Micr. Sci. 1875, xv., p. 413.

Ireland, Britain.

Plate LX. fig. 4. *Œdogonium macrandum* with oogonia and dwarf males × 400. Fig. 4. *a*, dwarf males seated upon the oogonium—after Wittrock.

Œdogonium crassiusculum. *Wittr. Disp. Œdog. p.* 132.

Gynandrosporous. Oogonia single, or twin, globose egg-shaped or nearly globose, opening by a pore above the middle; oospores ellipsoid-globose or globose; membrane very thick, almost filling the oogonia; androsporangia 2-5 celled; dwarf males nearly straight, seated on or about the supporting cells; spermogonia 1 (?) celled.

SIZE. Cells ·027-·03 mm., 3½ to 5 times as long; oogonia ·054-·06 × ·06-·075 mm.; oospore ·051-·057 × ·052-·063 mm.; androsp. cells ·026-·028 × ·01-·018 mm.; sperm. cell ·007-·009 mm.

Wittr. Mon. Œdog. p. 24.

Epping Forest (1882).

We have only found this species once in pools on the Loughton side of Epping Forest, but the very thick coat of the oospore is remarkably distinct, combined with other characters, so as to render its determination certain.

Plate LX. fig. 5. *Œdogonium crassiusculum* with oogonium and dwarf males; *a*, androsporangia; *o*, mature oospore × 400.

b. Oospores ellipsoid or egg-shaped.

Œdogonium Borisianum. (*Le Clerc.*) *Wittr. Disp. Œdog. p.* 132.

Gynandrosporous (or idio-androsporous ?). Oogonia single or twin, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, almost filling the oogonia; supporting cells swollen; androsporangia 2 ? celled, terminal cell (which sometimes is the oogonium) obtuse, dwarf males a little curved, seated on the supporting cells; spermogonia unicellular.

[redacted]

Œdogonium concatenatum. (*Hass.*) *Wittr. Mon. Œdog. p.* 25.

Gynandrosporous. Oogonia 2-6 continuous, or single, egg-shaped, or quadrangularly ellipsoid, opening by a pore above the middle; oospores filling the oogonia, sporoderm delicately porose; supporting cell swollen; androsporangia 2-4 celled; terminal cell obtuse, dwarf males curved, seated on the supporting cells; spermogonia 2-4 celled.

SIZE.—Cells ·025-·04 mm., 3-10 times as long; supporting cells ·058-·062 mm., $2\frac{1}{2}$ times as long; oogonia ·07-·083 × ·09-·105 mm.; oospores ·065-·076· × 087-·095 mm.; androsp. cell ·027-·028 × ·03-·036 mm.; sperm cell ·013-·015 × ·022-·025 mm.

Kirch. Alg. Schles. p. 55.

Vesiculifera concatenata, Hassall F. W. Algæ t. 51, f. 6.

Œdogonium apophysatum, Pringsh. Beitr. p. 71, t. 5, f. 9. Rabh. Alg. Eur. iii., 351, in part.

Britain.

Plate LXI. fig. 1. *Œdogonium concatenatum,* with oogonium and thickened supporting cell bearing the dwarf males; *a,* androsporangia × 400.

Œdogonium acrosporum. *De Bary. Œdog. p.* 60, *t.* 3, *f.* 1-12,

Idioandrosporous. Oogonia solitary, terminal, ellipsoid, opening by a small apical deciduous (or evanescent) operculum; oospore manifestly filling the oogonia, membrane longitudinally costate; supporting cells often swollen, terminal cell obtuse; dwarf males curved, seated on the supporting cells, stem often bicellular, upper cells of the stem very long; spermogonia 1-2 celled.

SIZE.—Cells ·01-·014 mm., 2-7 times as long; supporting cells ·015-·018 mm., 2-3 times as long; oogonia ·03-·035 × ·045-·051 mm.; sperm. cell ·006-·008 × ·014-·015 mm.

Archer in Quart. Journ. Micr. Sci. 1867, p. 80, 1868, p. 295. Wittr. Mon. Œdog. p. 16. Rabh. Alg. Eur. iii, 351.

Britain, Ireland.

The terminal oogonia are characteristic of this species, which can scarcely be confounded with any other.

Plate LXI. fig. 2. *Œdogonium acrosporum,* with terminal oogonia, after De Bary × 400.

Œdogonium ciliatum. (*Hass.*) *Prings. Beitr.* 70, *t.* 5, *f.* 8.

Gynandrosporous. Oogonia 2-7, continuous or single, egg-shaped, opening by an operculum, with a broad fissure; oospores egg-shaped, nearly filling the oogonia; androsporangia 2-8 celled, terminal cell setiform, dwarf males curved, seated on the oogonium; spermogonia unicellular.

Size. Cells ·015-·023 mm., 2½ to 4 times as long; oogonia ·043-·05 × ·055-·072 mm.; oospore ·04-·046 × ·047-·057 mm.; androsp. cell ·018-·02 × ·016-·02 mm.; sperm. cell ·008-·01 × ·01-·011 mm.

Wittr. Mon. Œdog. p. 27. Kirch. Alg. Schles. p. 56. Rabh. Alg. Eur. iii., 347.

Vesiculifera ciliata, Hass. F. W. Algæ 202, t. 52, f. 2.

Œdogonium piliferum, Auers. Rab. Alg. Sachs. No. 474.

Britain, Ireland.

Plate LXI. fig. 3. *Œdogonium ciliatum*, with oogonia and dwarf males; *a*, androsporangia; *b*, small plant (after Pringsheim); *c*, androspore × 400.

b. Membrane of oospore echinulate. Oospores globose.

Œdogonium Cleveanum. *Wittr. Disp. Œdog. p.* 129.

Gynandrosporous. Oogonia single, subglobose, opening by a pore below the middle; oospores almost filling the oogonium, globose, spinulose, spines conical spirally disposed; androsporangia 4-6 celled, dwarf males a little curved, seated on the supporting cell; spermogonia unicellular.

Size. Cells ·018-·026 mm., 3-7 times as long; oogonia ·052-·06 × ·059-·063 mm.; oospores ·049-·057 × ·051-·059 mm.; spines ·004 mm. long; androsp. cell ·018-·022· × 009-·018 mm.; sperm. cell ·008-·0085 × ·014-·016 mm.

Wittr. Mon. Œdog. p. 28. Kirch Alg. Schles. p. 56.

Œdogonium echinospermum, Pringsh. Beitr. 70, t. 5, f. 7. Rabh. Alg. Eur. iii., 349, in part.

Ireland.

[redacted]

Ireland, Scotland.

Of these two species with echinulate oospores, the spines of the former are broader at the base and conical, whilst in this they are slender, and but slightly thickened downwards.

Plate LXII. fig. 2. *Œdogonium echinospermum*, with oogonia and echinulate oospores × 400.

SUB-SECTION II. Diœcious, with elongated male plants. Oogonia, not, or scarcely, swollen.

Œdogonium capillare. (*Lin.*) *Kutz. Phyc. Gen.* 225, *t.* 12, *f.* 1-10.

Oogonia single, not swollen, cylindrical, opening by a pore above the middle; oospores globose or cylindrical-globose (somewhat quadrangular in longitudinal section) not filling the oogonia; male plants the same or almost the thickness of the female plants; spermogonia 1-4 celled, alternate with the vegetative cells: spermatozoids binate.

SIZE. Cells ·035-·055 mm., equal or twice as long; oogonia 1½ times as long; oospore ·03-·052 × ·039-·063 mm.; sperm. cell ·03-·048 × ·005-·006 mm.

Kirch. Alg. Schles. p. 56. Rabh. Alg. Eur. No. 1180, 1417. Wittr. Mon. Œdog. p. 30.

Conferva capillaris, Linn. Spec. Pl. 1636.

Œdogonium regulare, Vaup. Beitr. Œdog. p. 213, t. 1, f. 1-10, not the *Vesiculifera capillaris* of Hassall.

Britain.

Plate LXII. fig. 3. *Œdogonium capillare*, with oogonia × 400.

b. Oospores manifestly swollen.

aa. Oospores globose, or nearly so.

Œdogonium calcareum. *Cleve in Wittr. Disp. Œdog. p.* 135.

Oogonia single (very rarely twin), depressedly globose, opening by a pore at the middle; oospores filling the oogonia, male plants the same, or almost the same, thickness as the female; spermogonia 2-5 celled; spermatozoids single (?).

SIZE. Cells ·011-·014 mm., 2-4 times as long; oogonia ·027-·03 × ·021-·023 mm.; oospores ·026-·028 × ·02-·021 mm.; sperm. cell ·01-·011 × ·009-·012 mm.

Wittr. Mon. Œdog. p. 32.

Vesiculifera compressa, Hass. F. W. Algæ, 204, t. 53, f. 4.

Œdogonium compressum, Rabh. Alg. Eur. iii., 348.

Britain.

Specimens from the warm tank in the Victoria House, Kew Gardens, had shorter cells than usual. It has apparently a tendency to become more or less coated with a deposit of lime.

Plate LXII. fig. 4. *Œdogonium calcareum*, with portions of male and female plants; *a*, female plant from Victoria tank, Kew Gardens × 400.

Œdogonium cardiacum (*Hass*). *Wittr. Disp. Œdog.* 135.

Oogonia single, between heart-shaped and globose, opening by a pore a little above the middle; oospores globose, not filling the oogonia; male plants a little slenderer than the female; spermogonia 2-10 celled; spermatozoids binate, terminal cells obtuse.

SIZE. Cells: fem. ·018-·03 mm. 2-7 times as long; cells: male ·015-·025 mm. 2-6 times as long; oogonia ·05-·07 × ·058- 086 mm.; oospore ·042-·06 × ·042-·06 mm.; sperm. cell ·015-·021 × ·01-·013 mm.

Wittr. Mon. Œdog. p. 33; Kirch. Alg. Schles. p. 57.
Vesiculifera cardiaca, Hass. F. W. Algæ 203, t. 51, f. 4.
Vesiculifera pulchella, Hass. F. W. Algæ 199, t. 50, f. 3.
Œdogonium pulchellum, Rabh. Alg. Eur. iii. 356.

Britain.

Plate LXII. fig. 5. *Œdogonium cardiacum*, oogonia with oospores × 400.

Œdogonium carbonicum. *Wittr. Mon. Œdog.* p. 74.

Oogonia single or twin, obversely egg-shaped—or ovate—globose, opening by a pore above the middle; oospores ellipsoid-globose or nearly globose, scarce filling the oogonia; male plants a little slenderer than the female; spermogonia 2-5 celled; spermatozoids binate; terminal cell obtuse.

SIZE. Cells: fem. ·016-·03 mm. 3-6 times as long; cells: male ·014-·016 mm. 3-6 times as long; oogonia ·043-·052 ×

·036-·045 mm.; oospore ·028-·035 × ·028-·034 mm.; sperm. cell ·01-·015 × ·006-·009 mm.

Kirch. Alg. Schles. p. 57; Rabh. Alg. iii. 348. Rabh. Alg. Eur. No. 790; Wittr. Mon. Œdog. p. 33, t. 1, fig. 16-17.

Œdogonium Nordstedtii, Wittr. Œdog. Nov. 6, t. 1, f. 7-8.

Britain.

Plate LXIII. fig. 2. *Œdogonium Pringsheimii*, with oogonia × 400.

Œdogonium punctato-striatum. *De Bary Œdog. t.* 2, *f.* 15-16.

Oogonia single, depressedly globose, manifestly splitting round (circumscissile) in the middle, opening by a pore in the fissure; oospore depressedly globose, nearly filling the oogonia; male plants a little slenderer than the female; spermogonia 3-7 celled; spermatozoids single; membrane of the vegetative cells and of the oogonia spirally punctate; basal cell depressedly globose; membrane vertically plicate.

SIZE. Cells: fem. ·018-·022 mm. 2-6 times as long; cells: male ·016-·019 mm. 2-6 times as long; oogonia ·048-·055 × ·038-·048 mm.; oospore ·044-·051 × ·035-·043 mm.; sperm. cell ·016-·018 × ·006-·01 mm.

Barker. P., in Quart. Jour. Micr. Sci. 1871, p. 94; Rabh. Alg. iii. 354. Rabh. Alg. Sachs. 214. Wittr. Mon. Œdog. p. 34. Rabh. Alg. Eur. No. 2276. Kirch. Alg. Schles. p. 57.

Ireland.

Distinguished by the cell wall being marked by spiral striæ of a dotted character, finely and closely set; these seen in an empty cell, through and through, the upper and lower striæ being nearly in focus simultaneously produce a somewhat decussate appearance.

Plate LXIII. fig. 3. *Œdogonium punctato-striatum*, with oogonium × 400.

bb. Oospores ellipsoid or egg-shaped.

Œdogonium Boscii (*Le Clerc*). *Wittr. Lisp. Œdog. Suec. p.* 136.

Oogonia single, rarely twin, oblong-ellipsoid, opening by a pore above the middle; oospores ellipsoid, by no means filling the oogonia, longitudinally costate; male plants the same or nearly the thickness of the female; spermogonia 3-6 celled; spermatozoids binate; terminal cell slender and somewhat hyaline.

SIZE. Cells ·014-·02 mm. 4-6 times as long; oogonia ·04-·045 × ·08-·1 mm.; oospore ·036-·04 × ·06-·065 mm.; sperm. cell ·013-·014 × ·006-·009 mm.

Wittr. Mon. Œdog. p. 34. Rabh. Alg. Eur. iii. 357. Rabh. Alg. Eur. No. 2198, 2369.

Vesiculifera Boscii, Hassall Algæ t. 52, f. 3, 4, 5.
Prolifera Boscii, Le Clerc Prolif. 474, t. 23, f. 5.
Vesiculifera elegans, Hass. Ann. Nat. Hist.

England.

Plate LXIII. fig. 4. *Œdogonium Boscii*, with oogonia × 400.

Œdogonium tumidulum. *Kutz. Dec. Alg. No.* 60.

Oogonia single, ellipsoid egg-shaped, opening by a pore above the middle, almost filling the oogonium; male plants a little slenderer than the female; spermogonia 6-45 celled; spermatozoids binate.

SIZE. Cells: fem. ·018-·025 mm. 3½-5 times as long; cells: male ·015-·018 mm. 4 times as long; oogonia ·056-·058 × ·078-·09 mm.; oospore ·049-·054 × ·061-·068 mm.; sperm. cell ·015-·017 × ·009-·012 mm.

Wittr. Mon. Œdog. p. 35. Kirch. Alg. Schles. p. 58 (not of Pringsheim).

Ireland.

Plate LXIII. fig. 5. *Œdogonium tumidulum* with oogonium. 5 *a*, portion of male plant with spermogonia × 400.

Œdogonium Landsboroughii (*Hass*). *Wittr. Mon. Œdog. p.* 35.

Oogonia single, rarely twin, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, filling the oogonia (or rarely ellipsoid and not filling the oogonia); male plants a little slenderer than the female; spermogonia 5-25 celled; spermatozoids binate, with a vertical division; terminal cell obtuse.

[redacted]

Size. Cells: fem. ·02-·027 mm. 3-5 or 8 times as long; oogonia ·055-·057 × ·075-·08 mm.; oospore ·049-·051 × ·065-·069 mm.

Kirch. Alg. Schles. p. 58. Archer in Quart. Journ. Micr. Sci. 1866, p. 69.

Œdogonium gemelliparum, Pringsh. Beitr. p. 71.

Ireland.

Plate LXIV. fig. 2. *Œdogonium Landsboroughii*, variety *gemelliparum*, with oogonium × 400.

Œdogonium rivulare (*Le Clerc*). *Braun, Chytr. p.* 23, *t.* 1, *f.* 1-10.

Oogonia single, or 2-7 continuous, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, rarely ellipsoid or nearly globose, not by a long way filling the oogonia; male plants a little slenderer than the female; spermogonia 3-9 celled; spermatozoids binate.

Size. Cells: fem. ·045-·045 mm. 3-8 times as long; cells: male ·03-·036 mm. 4 times as long; oogonia ·07-·085 × ·13-·16 mm.; oospore ·055-·07 × ·065-·1 mm.; sperm. cell ·021-·028 × ·014-·016 mm.

Wittr. Mon. Œdog. p. 36. Kirch. Alg. Schles. p. 58. Rabh. Alg. Eur. iii. 350 in part.

Prolifera rivularis, Le Clerc Prolif. 472, t. 23, f. 1.

Scotland.

Plate LXIV fig. 3. *Œdogonium rivulare*, with oogonium and oospore × 400.

Species of which the organs of fructification are imperfectly known.

a. Oospores globose or sub-globose.

Œdogonium delicatulum. *Kutz. Tab.* III., *t.* 33, *f.* 3.

Pallid, basal cell scarcely lobed at the base, affixed, cells cylindrical; oogonia subglobose, inflated, a little extended at either pole; oospore perfectly globose.

Size. Cells ·005-·006 mm., 3 times as long; oogonia ·02 × ·017 mm.; oospores ·012-·014 mm.

Rabh. Alg. Eur. 355. Rabh. Alg. Ex. No. 1156.

Deeside (Scotland).

Plate LXVI. fig. 7. *Œdogonium delicatulum*, with oogonia × 400.

Œdogonium tenellum. *Kutz. Tab.* III., *t.* 33, *f.* 9.

Basal cell two to three lobed, at first fixed, terminal joint obtuse, cells cylindrical or rather clavate; oogonia very much inflated; oospore globose, bright orange.

SIZE. Cells ·009-·011 mm., 4-8 times as long; oogonia ·025 mm. diam; oospore ·016-·018 mm.

Rabh. Alg. Eur. iii., 355.

Deeside (Scotland).

Plate LXVI. fig. 6. *Œdogonium tenellum*, with oogonia × 400.

Œdogonium hexagonum. *Kutz. Tab.* III., *t.* 35, *f.* 3.

Oogonia almost globose; oospores globose, rufous-brown, not filling the oogonia; basal cell bifurcate; terminal cell often setigerous.

SIZE. Cells ·011-·013 mm. 2-4 times as long; oogonia ·025 × ·025 mm.; oospore ·016 mm.

Rabh. Alg. Eur. iii. 354.

Vesiculifera hexagona Hassall Algæ t. 53, f. 11-12.

Deeside (Scotland).

Plate LXVI. fig. 8. *Œdogonium hexagonum*, with oogonia × 400.

Œdogonium Londinense. *Wittr. Mon. Ædog. p.* 39.

Monœcious? oogonia twin or single, globose, cut round (circumscissile) in the middle, opening by a pore seated in the fissure; oospores globose, almost filling the oogonia; spermogonia (or androsporangia?) 1-2 celled, hypogynous.

SIZE. Cells ·01-·015 mm. 1½ to 5 times as long; oogonia ·033-·035 × ·033-·043 mm.; oospore ·027-·032 × ·027-·032 mm.; sperm. cells ·026-·027 × ·027-·029 mm.

England.

Plate LXV. fig. 4. *Œdogonium Londinense* with oogonia × 400.

[redacted]

globose, rufous-brown when mature, loosely involved in the oogonium.

SIZE. Cells ·02-·025 mm. 1½-3 times as long; oogonia ·05 × ·04 mm.; oospore ·03-·032 mm.

Kutz. Tab. iii., t. 39, f. 6. Rabh. Alg. Eur. iii., 353.

Deeside (Scotland).

Plate LXVI. fig. 3. *Œdogonium capillaceum,* with oogonia × 400.

Œdogonium Hutchinsiæ. *Wittr. Mon. Œdog. p.* 42.

Oogonia single, rather depressedly to somewhat egg-shaped globose, opening by a pore above the middle; oospores filling the oogonium, epispore punctate with little warts; supporting cells swollen.

SIZE. Cells ·03-·035 mm., 4-6 times as long; oogonia ·062-·075 × ·065-·095 mm.; oospores ·06-·073 × ·055-·072 mm.; supporting cells ·04-·05 mm. 2-4 times as long.

Ireland.

The figure is taken from original specimens from Miss Hutchins in the Royal Herbarium at Kew.

Plate LXV. fig. 1. *Œdogonium Hutchinsiæ,* with oogonia × 400.

Œdogonium princeps. (*Hass*). *Wittr. Mon. Œdog. p.* 42.

Oogonia single, somewhat egg-shaped globose, opening with a pore above the middle; oospores globose, not distinctly filling the oogonium.

SIZE. Cells ·037-·045 mm. 1¼-2¼ times as long; oogonia 061-·075 × ·068-·08 mm.; oospore ·058-·066 × ·06-·065 mm.

Vesiculifera princeps Hass. F. W. Alg. 195.

Vesiculifera capillaris Hass. F. W. Alg. 195, t. 50, f. 1-2.

England.

Plate LXV. fig. 2. *Œdogonium princeps,* with oogonia and (*a*) spermogonia (?) × 400.

b. Oospores subelliptic or oval.

Œdogonium longatum. *Kutz. Sp. Alg. p.* 364.

Oogonia single (often solitary, terminal), rarely 2-3 continuous, ellipsoid, opening by an operculum, with a narrow fissure; oospores globosely-ellipsoid, scarcely filling the oogonium; terminal cell obtuse.

SIZE. Cells ·005-·006 mm. 2-3 times as long; oogonia ·016-·017 × ·021-·024 mm.; oospores ·015-·016 × ·0175-·0185 mm.

Kutz. Tab. Phy. iii., t. 33, f. 6. Wittr. Mon. Œdog. p. 38.

Britain.

Plate LXIV. fig. 4. *Œdogonium longatum*, parasitic upon another species, with oogonia × 400.

Œdogonium vesicatum. (*Lyngb.*) *Wittr. Mon. Œdog. p.* 39.

Oogonia single, ellipsoid, globose, opening by an operculum, with a narrow fissure; oospores ellipsoid-globose, almost filling the oogonium.

SIZE. Cells ·017-·21 mm. 1½-3 times as long; oogonia ·043-·045 × ·051-·06 mm.; oospore ·037-·038 × ·041-·042 mm.

Kirch. Alg. Schles. p. 59.

Conferva vesicata Lyngb. Hydro. 144, t. 47, f. D 1. Eng. Bot. t. 2476.

Scotland.

Plate LXV. fig. 5. *Œdogonium vesicatum*, with oogonium × 400.

Œdogonium grande. *Kutz. Tab. Phy.* III, *t.* 37, *f.* 1.

Oogonia oval-elliptic, nearly twice as long as broad; oospores oval-elliptic, entirely filling the oogonia; basal cell contracted towards the base, then dilated and discoid; terminal cell obtuse.

SIZE. Cells ·025-·035 mm. 3-4 or 5 times as long; oogonia ·1 × ·07 mm.; oospore ·09 × ·065 mm.

DeBary Œdog. t. 2, f. 1-14. Rabh. Alg. Eur. iii., 353.

Scotland.

Œdogonium crassum. (*Hass.*) *Wittr. Gotl. Sotv. Alg. p.* 20, *t.* 1. *f.* 4-6.

Oogonia single (rarely twin), obversely egg-shaped ellipsoid, a little swollen, opening by a pore above the middle; oospores ellipsoid, not filling the oogonia.

SIZE.—Cells ·033-·055 mm. 2-5 times as long; oogonia ·065-·07 × ·1-·125 mm.; oospore ·06-·066 × ·08-·11 mm.

Wittr. Mon. Œdog. p. 43. Kirch. Alg. Schles. p. 59.

Vesiculifera crassa Hass. Alg. t. 51, f. 1.

Plate LXVI. fig. 1. Œdogonium crassum, with oogonium × 400.

Œdogonium subsetaceum. *Kutz. Spec. p.* 368.

Basal cell dilated and discoid at the base, rather lobed, terminal joint obtuse; oospores broadly oval, golden red, closely involved in the oogonium.

SIZE. Cells ·04-·052 mm. equal or twice as long; oogonia ·065 × ·055 mm.; oospore ·06 × ·05 mm.

Kutz. Tab. iii, t. 41, f. 1. Rabh. Alg. Eur. iii, 352.

Deeside (Scotland).

Plate LXVI. fig. 5. Œdogonium subsetaceum, with oogonium × 400.

GENUS 65. BULBOCHŒTE. *Ag.* (1817.)

Filaments articulated, branched, joints thickened upwards, at or about the apex bearing setæ, which are straight, hyaline, colourless, more or less elongated, bulbous at the base, cell membrane usually punctate; oogonia opening by a lateral pore above the middle; mature oospore red; monœcious or diœcious.

Reproduction sexual as in *Œdogonium.* In the diœcious species nannandrous (dwarf males).

The following arrangement of the British species is based on that of Prof. Wittrock:—

BULBOCHŒTE.

Sect. 1. Oogonia globose or subglobose, patent; oospores with the same form, and filling the oogonia. Diœcious.

A. *Dwarf males unicellular.*
None.

B. *Dwarf males bicellular.*
a. Basal cell of the stem of the male plants shorter than the spermogonia.
B. intermedia, *DBary.*
B. polyandra, *Cleve.*
B. Brebissonii, *Kutz.*
B. setigera, *Ag.*

b. Basal cell of the stem of the male plants longer than the spermogonia.
B. gigantea, *Pring.*

Sect. 2. Oogonia ellipsoid or subellipsoid; oospores of the same form, filling the oogonia, epispore longitudinally costate, costæ more or less crenulate.

Sub-Sect. 1. Species monœcious.
B. mirabilis, *Wittr.*

Sub-Sect. 2. Species diœcious.

A. *Dissepiment of supporting cell obsolete.*
B. pygmæa, *Pring.*

B. *Dissepiment of supporting cell present.*
B. insignis, *Prings.*
B. rectangularis, *Wittr.*

Species of which the organs of fructification are imperfectly known.
B. gracilis, *Prings.*

SECTION 1. Oogonia globose, or subglobose; diœcious.

B. *Dwarf males bicellular.*

Bulbochœte intermedia. *DeBary Œdog.* 72, *t.* 4, *f.* 1-7.

Oogonia somewhat depressedly globose, seated beneath the androsporangia, dissepiment of the supporting cell in the middle; epispore delicately crenulate (rarely seen); androsporangia 1-2 celled, epigynous, rarely scattered, dwarf males seated on the oogonia, stem slightly curved.

SIZE. Cells ·017-·019 mm. 1½-3 times as long; androspore cells ·013 × ·01 mm.; oogonia ·04-·048 × ·031-·04 mm.; dwarf males ·009-·01 × ·024-·026 mm.

Wittr. Mon. Œdog. p. 44, t. 1, f. 18. Kirch. Alg. Schles. p. 60. Rabh. Alg. Eur. iii, 358.

Britain, Ireland.

[redacted]

Bulbochæte Brebissonii. *Kutz. Tab. Phyc.* IV, 19, *t.* 86.

Oogonia obcordate-globose, truncate below, erect, seated beneath terminal setæ or androsporangia, dissepiment of supporting cell low, epispore delicately crenulate ; androsporangia 2-3 celled, scattered or epigynous ; dwarf males seated on the oogonia, rarely around it, stem straight, or nearly so.

SIZE. Cells ·017-·02 mm. by 3-4½ times as long ; androspore cells ·015 × ·015-·018 mm. ; oogonia ·042-·05 × ·037-·045 mm. ; dwarf males ·01-·012 × ·028-·033 mm.

Wittr. Mon. Œdog. p. 46. Rabh. Alg. Eur. Exs. 1055. Rabh. Alg. Eur. iii. 359.

Ireland.

Plate LXVII. fig. 3. *Bulbochæte Brebissonii*, with oogonia, and dwarf males × 400.

Bulbochæte setigera. *Ag. Syn. Alg. Scan. p.* 71.

Oogonia depressedly, somewhat quadrangularly globose, seated beneath terminal setæ, or beneath androsporangia ; membrane of the oogonium after fertilisation thickened ; dissepiment of supporting cell a little above the middle, or at the middle ; epispore granulated ; androsporangia scattered or epigynous, bicellular; dwarf males seated upon or about the oogonia, stem straight.

SIZE. Cells ·025-·028 mm., 2½-5 times as long ; androspore cells ·018-·02 × ·014-·018 mm. ; oogonia ·075-·08 × ·06-·065 mm. ; dwarf males, ·012-·013 × ·034-·036 mm.

Wittr. Mon. Œdog. p. 47. Prings. Beitr. 72, t. 6, f. 3. Kirch. Alg. Schles. p. 61. Rabh. Alg. Eur. iii., p. 358. Hass. Alg. t. 54, f. 1-4. Eng. Bot. ii. t. 2472. Eng. Fl. v, p. 350.

Conferva vivipara Dillw. Conf. t. 59. Eng. Bot. i, 2086.

Bulbochæte Rothii Gray. Arr. 1, 321 (?).

Britain, Ireland.

Plate XLVIII. fig. 1. *Bulbochæte setigera*, with oogonia and dwarf males ; *a, b, c*, development of young plants × 400.

Bulbochæte gigantea. *Prings. Beitr.* 71, *t.* 6, *f.* 1.

Idio-androsporous? Oogonia rather depressed obcordate-globose, seated beneath terminal setæ, rarely beneath vegetative cells ; dissepiment of supporting cell at or a little above the middle ; epispore verrucose ; dwarf males a little longer than the oogonia, and seated upon it ; stem twice as long as the spermogonium, arcuate.

SIZE. Cells ·024-·027 mm. by 2-3 times as long ; oogonia ·062-·066 × ·051-·058 mm. ; stem of dwarf males ·011-·012 × ·04-·045 mm. ; sperm. cell ·013-·014 × ·02-·022 mm.

Wittr. Mon. Œdog. p. 48. Kirch. Alg. Schles. p. 61. Rabh. Alg. Eur. iii., p. 357. Quart. Journ. Micr. Sci., 1866, p. 276.

Britain, Ireland.

Plate LXVIII. fig. 4. *Bulbochæte gigantea,* with oogonium and dwarf male × 400.

SECTION 2. Oogonia ellipsoid or subellipsoid.

SUB-SECTION 1. Species monœcious.

Bulbochæte mirabilis. *Wittr. Disp. Œdog.* 137, *t.* 1, *f.* 8, 9.

Oogonia ellipsoid, or rather oblong-ellipsoid, patent, or rarely erect, seated beneath terminal setæ or vegetative cells ; spermogonia 2-4 celled, erect (rarely patent), subepigynous, or scattered.

SIZE. Cells ·016-·02 mm. 1$\frac{1}{4}$-1$\frac{3}{4}$ times as long ; oogonia ·027-·035 × ·046-·056 mm. ; sperm. cell ·01-·012 × ·007-·009 mm.

Wittr. Mon. Œdog. p. 50.

Britain, Ireland.

Plate LXVIII. fig. 2. *Bulbochæte mirabilis,* with oogonia and androsporangia × 400.

SUB-SECTION 2. Species diœcious.

Bulbochæte pygmæa. *Wittr. Disp. Œdog. p.* 141.

Oogonia ellipsoid, patent, seated beneath terminal setæ, or vegetative cells, in longitudinal section rather quadrangular; androsporangia scattered, dwarf males seated about the oogonia. (Filament at first short, and curved.)

[redacted]

Size. Cells ·02-·025 mm. 2½-4½ times as long; oogonia ·046-·05 × ·07-·1 mm.; androspore cell ·016-·02 × ·02-·025 mm.; stem of dwarf males ·017-·019 × ·029-·031 mm.; sperm. cell ·01-·011 × ·0075-·008 mm.

Wittr. Mon. Œdog. p. 55. Kirch. Alg. Schles. p. 62. Rabh. Alg. Eur. iii. 360.

Bulbochæte Pringsheimiana Arch. Proc. Dubl. Micro. Club p. 38, t. 4.

Ireland.

Plate LXVII. fig. 4. *Bulbochæte insignis*, with oogonium and dwarf male × 400.

Bulbochæte rectangularis. *Wittr. Disp. Œdog. p.* 142.

Oogonia ellipsoid, patent, or rarely erect, seated beneath terminal setæ, or androsporangia, or rarely beneath vegetative cells; androsporangia scattered or epigynous; vegetative cells somewhat rectangular in longitudinal section (horizontal division of vegetative cells often occurs). Branches of the plant few and very long; dwarf males seated about or upon the oogonia.

Size. Cells ·019-·023 mm., 1¼-2 times as long; oogonia, ·03-·039 × ·048-·055 mm.; androspore cell ·015-·016 × ·016-·027 mm.; stem of dwarf males ·015-·018 × ·022-·027 mm.; sperm. cell ·008-·0095 × ·0055-·0065 mm.

Wittr. Mon. Œdog. p. 56, t. 1, f. 22-24.

Ireland.

Plate LXVIII. fig. 3. *Bulbochæte rectangularis*, with oogonia and dwarf male × 400.

Species of which the organs of fructification are imperfectly known.

Bulbochæte gracilis. *Prings. Beitr.* 74, *t.* 6, *f.* 9.

Monœcious (?). Oogonia oblong-ellipsoid, patent or rarely erect, with vegetative cells above; supporting cells without dissepiment (?).

Size. Cells ·013-·014 mm., 1¼ to 1½ times as long; oogonia ·021-·024 × ·049-·054 mm.

Wittr. Mon. Œdog. p. 57. Rabh. Alg. Eur. iii., 359. Quart. Journ. Micr. Sci. 1870, p. 89.

Ireland.

Plate LXVI. fig. 9. *Bulbochæte gracilis*, with oogonium × 400.

Family VI. ULOTRICHEÆ.

Algæ growing either in fresh water (*Ulothrix*), or marine or sub-marine (*Hormiscia*), or terrestrial (*Hormidium*, *Schizogonium*), either of a bright green or yellowish green colour. Threads very shortly articulate, simple, very rarely dividing into single branches, free, now and then laterally connate in bands (*Schizogonium*).

Primitive cells always many times longer than their diameter, after repeated division equal, or shorter (rarely a little longer), all fertile. Cell-membrane either thin (*Ulothrix*, *Hormidium*) or thick, sometimes very thick, and distinctly lamellose (*Hormiscia*). Cell-contents at first effused, parietal, including a starch granule, after simple or repeated division transmuted into gonidia.

Gonidia of two kinds, *Macrogonidia* sphærical, ovoid, or ovate-oblong, rounded at one pole, and acute at the other, furnished with 2 or 4 vibratile cilia, often germinating in the mother-cell without sexual fertilization. *Microgonidia* much smaller, of similar form, furnished with two cilia at one extremity. Both kinds of zoogonidia produced within the cells of the threads, emitted either by a poriform opening in the mother-cell, or by the splitting or breaking up of the mother-cell.

For detailed information on this family consult Braun's "Rejuvenes- [redacted]

The filaments are sometimes cylindrical, sometimes torulose like a rosary, in consequence of the barrel-like inflation of the separate cells; sometimes stretched out, sometimes frilled and interlacing each other, with a relatively thicker stratified membrane. Vegetative or asexual reproduction is effected by macrozoospores, which originate 1-4 in a cell, and after becoming covered with a transparent bladder make their exit through an opening formed in the lateral wall of the mother-cell. The macrozoospores are of a thick, short, pear-shape, furnished with four cilia, a coloured spot, and a contractile vacuole. After a time they come to rest, and fixing themselves by the mouth end, they lose their cilia and envelope themselves in a membrane. The fixed end developes into a root-like, colourless organ of attachment; the free end growing into a club-shaped plantlet, through the cell, dividing into two by a cross partition, and each of these again in two, and so further. Sexual reproduction arises through repeated bipartition in each cell, from 8-32 and more, smaller microzoospores being produced. They have only two cilia, and after a swarming for a time they conjugate laterally in pairs, forming a zygospore, which attaches itself by the end corresponding to the mouth of the microzoospore. It grows very slowly, and finally breaks up by the simultaneous division of its plasma into 2-14 swarm-spores, which constitute the beginning of a new sexual generation. If any of the microzoospores remain behind in the mother cells, they are able, without copulation, to germinate and grow into independent plants which may be seen singly or in groups projecting from the mother-cells.

Hormiscia moniliformis. (*Kutz.*) *Rabh. Alg. Eur.* III., 361.

Pale green, more or less crispate, often mixed with other Algæ; cells equal or a little shorter than their diameter; cell-membrane thick, colourless, somewhat lamellose, more or less constricted at the septa.

SIZE. Cells ·011-·014 mm. diam.

Ulothrix moniliformis, Kutz. Tab. Phy. ii., t. 88. Kirch. Alg. Schl. p. 76.

In swamps, amongst *Sphagnum*, &c.

Plate LXX. fig. 1. Portions of threads of *Hormiscia moniliformis* × 400 diam.

Hormiscia zonata. (*Web. & M.*) *Aresch. Obs. p.* 12.

More or less bright green, mucous, two or three feet long, often less, either floating or interwoven, sterile cells equal, or half their diameter; fructiferous cells usually a little longer than broad; cell-membrane thick, slightly constricted at the septa.

SIZE. Cells ·012-·04 mm.; macrozoospores ·012-·018 × ·01 ·012 mm.; microzoospores ·005-·01 × ·004-·007 mm.

Rabh. Alg. Eur. iii., 362.

Ulothrix zonata, Kutz. Tab. Phy. ii., t. 90, f. 2. Kirch. Alg. Schl. p. 76. Dodel in Prings. Jahrb. t. x., pl. I.-VIII.

Lyngbya zonata, Hass. Alg. 220, t. 59, f. 1-6.

Conferva zonata, Web. & Mohr. in Ag. Syst. p. 90; Harv. Man. 126. Eng. Fl. v., p. 351. Mack. Hib. 224. Dillw. Conf. Syn. p. 41. Johnst. Fl. Berw. ii., 254. Gray Arr. i., 311.

Conferva lubrica, Dillw. Conf. t. 47.

Conferva lucens, Eng. Bot. i., t. 1655; ii., t. 2475.

In ditches, ponds, swamps, &c.

Plate LXIX. fig. a. } Threads in ordinary condition.
„ *b.* }
„ *c.* Portion of a thread with one macrozoospore in each cell showing the red spot.
„ *d.* Macrozoospores free with four cilia.
„ *e.* Macrozoospores in the resting state.
„ *f.* Macrozoospores germinating.
„ *g.* Plantlet of six cells.
„ *h.* Threads with ripe microzoospores.
„ *h2.* With macro and microzoospores.
„ *i.* Microzoospores free with two cilia.
„ *k.* Microzoospores in conjugation.
„ *l.* Resting zygospores, the result of the conjugation of pairs of zoospores.
„ *m.* Portion of threads with growing plantlets arising from uncopulated microzoospores left behind in the mother-cells.
„ *n.* Three healthy zygospores, 8 months and 9 days old.
„ *o.* Zygospore contents differentiating.
„ *p.* „ in a later stage.
„ *q.* „ very large in two positions, showaltogether 10 zoospores.
„ *r.* „ with zoospores elongated.

Hormiscia æqualis. (*Kutz.*) *Rabh. Alg. Eur.* III., 363.

[redacted]

Hormiscia speciosa. (*Carm.*) *Rabh. Alg. Eur.* III., 363.

Dark green, 1-2 inches long, threads often crispate, cells 2-4 times shorter than their diameter, fructiferous cells subglobose.

SIZE. Cells ·043-·048 mm. diam.

Ulothrix speciosa, Kutz. Tab. Phy. ii., t. 93.

Lyngbya speciosa, Carm. Alg. App. ined. Harv. Phyc. Britt. t. 186 B. Brit. Fl. ii., 371. Wyatt Alg. Danm. No. 196.

In brackish and fresh water.

Scarcely any good features whereby this can be distinguished from *H. bicolor*.

Plate LXX. fig. 3. Portions of threads of *Hormiscia speciosa* × 400 diam.

Hormiscia bicolor. (*Eng. Bot.* I., *t.* 2288.)

Bright green. Tufts very long, one foot or more; articulations two to three times shorter than their diameter, pectinate; cell membrane thick, distinctly lamellose.

SIZE. Cells ·05 mm. diam.

Ulothrix crispa, Kutz. Tab. Phyc. ii., t. 92, f. 4. Kutz. Spec. 348.

Conferva bicolor, Eng. Bot. i., t. 2288.

Tyndaridea bicolor, Eng. Bot. ii., t. 2508. Eng. Fl. v., 361.

Ulothrix bicolor, Ralfs, Alg. Exs. No. 13.

(?) *Sphæroplea crispa*, Berk. Glean. t. 3, f. 1. Harv. Man. 144.

Lyngbya crispa, Jenner Fl. Tonb. Wells, 188.

In fresh water.

Whether this be really the *Sphæroplea crispa* of "Berkeley's Gleanings" seems open to reasonable doubt.

Plate LXX. fig. 7. Portion of thread of *Hormiscia bicolor* with microzoospores in lower cells × 400 diam.

GEN. 67. **ULOTHRIX.** *Kutz.* (1845.)

Threads articulate, simple; articulations short, sometimes shorter than their diameter, rarely a little longer; cell membrane thin, often very thin, very rarely lamellose. Cell contents effused, green, parietal, inclosing an amylaceous granule.

The slight differences between this genus and *Hormiscia* seems scarcely sufficient to maintain them as distinct genera.

Ulothrix variabilis. *Kutz. Tab. Phyc.* II., *t.* 85, *f.* 3.

Pale green; cells equal or a little longer than their diameter, rarely twice as long; cell-contents at first always contracted in a quadrate manner.

SIZE. Cells ·005-·007 mm.

Rabh. Alg. Eur. iii.

Ulothrix subtilis, var. c. *variabilis*, Kirch. Alg. Sch. 77.

In ditches and slow streams.

The view entertained by Kirchner that this and *U. tenerrima* are only varieties of *Ulothrix subtilis* is probably correct.

Plate LXX. fig. 4. Portions of threads of *Ulothrix variabilis* × 400 diam.

Ulothrix tenerrima. *Kutz. Tab. Phy.* II., *t.* 87, *f.* 1.

Pale green, or yellowish-green, lubricous; cells mostly equal in length and diameter, now and then a little shorter.

SIZE. Cells ·007-·01 mm.

Rabh. Alg. Eur. iii., 366.

Ulothrix subtilis, var. *e. tenerrima*, Kirch. Alg. Schl. p. 77.

In ditches, turbaries, &c.

Plate LXX. fig. 5. Portions of threads of *Ulothrix tenerrima* × 400 diam.

Ulothrix tenuis. *Kutz. Tab. Phyc.* II., *t.* 89, *f.* 1, *bis.*

Dark green, attached, from half to two or three inches long, mucous, cells equal or 2-4 times shorter than their diameter,

[redacted]

Wells, 188. Harv. Man. 160. Johnst. Fl. Berw. ii., 259. Mack. Hib. 238.

Conferva muralis, Dillw. Conf. t. 7. Eng. Bot. i., t. 1554.

Humida muralis, Gray Arr. i., 282.

Oscillatoria muralis, Grev. Fl. Ed. 304. Fl. Dev. ii., 57. Hook. Fl. Scot. ii., 79.

On the naked ground, rocks, walls, &c.

Kutzing has in some of his works applied to the terrestrial species of *Ulothrix* the generic name of *Hormidium*, which is only of sectional value.

Plate LXXI. fig. 1. Portions of threads of *Ulothrix radicans* × 400.

Ulothrix (Hormidium) parietina. (*Vauch.*) *Kutz. Tab. Phyc.* II., *t.* 97, *f.* 1.

Bright yellowish green, flexuous and interwoven, cells half as long as broad, cell membrane thin, hyaline, homogeneous.

SIZE. Cells ·009-·016 mm.

Rabh. Alg. Eur. iii., 367. Kirch. Alg. Schl. p. 78.

Hormidium parietinum, Kutz. Phyc. Germ. p. 193.

On walls, trunks, &c.

Plate LXXI. fig. 2. Portions of threads of *Ulothrix parietina* × 400 diam.

GEN. 68. SCHIZOGONIUM. *Kutz.* (1843.)

Threads as in *Ulothrix*, or in many places laterally connate (duplicate or triplicate), or by cellular division in two directions forming narrow flat bands, which are more or less crispate.

In 1861 Dr. Braxton Hicks indicated his belief that *Schizogonium* was only a condition of *Ulothrix* in which the threads had become connate, of which *Prasiola* was only a frondose form. He says, "the whole of these changes are so palpable, can be observed so constantly, and are, at the same time, so simple in their relations to one another, that one can scarcely imagine how they can have been separated, not only into distinct species, but into different families of Algæ. Thus the linear stage is called *Lyngbya* (Ulothrix); the early stage of collateral segmentation, the *Schizogonium*; the adult stage, the *Prasiola*; while the gonidial growth has been classed under *Palmellaceæ*." And again, "the only real difference between the first two is, that whereas *Lyngbya* (Ulothrix) is a tube containing distinct cells within, which, when old undergo collateral subdivision, to form a band of two, four, or eight rows of cells, *Schizogonium* is a band of two or eight rows of cells, which, when young was but a single row, contained in a tube, which is only two different ways of stating the same facts. The comparison of the last two is of the same kind. For as *Prasiola*, when old, is composed of many rows of cells, but which arose from a single row, there must have been a time in its life when it had two, four, or eight rows, and thus have been a *Schizogonium*, for there is no other

structural difference between the two." The whole of the communication from whence the above is quoted is worthy of attentive perusal, at least in so far as the relations between *Ulothrix* and *Schizogonium* are concerned. It is entitled "On the Diamorphosis of *Lyngbya*, &c.," in the "Quart. Journ. of Microscopical Science" for 1861, pp. 157–166.

Schizogonium murale. *Kutz. Tab. Phyc.* II., *t.* 98, *f.* 1.

Dark green, forming a broadly expanded soft velvety stratum, threads sometimes free, here and there two or three united, cells 2-4 times shorter than their diameter, pectinate, often crowded, sometimes interrupted, cell membrane rather thick, colourless, slightly undulated and constricted.

SIZE. Cells ·015–·018 mm.

Rabh. Alg. Eur. iii., 368. Kirch. Alg. Schl. 78.

On moist walls and naked ground.

Plate LXXI. fig. 3. Portions of threads of *Schizogonium murale* × 400 diam.

FAMILY VII. CHROOLEPIDEÆ.

Aerial algæ, coloured golden yellow, orange or red-brown, when dry often becoming greenish grey; more or less fragrant with the odour of violets. Threads articulate, variously branched, cell membrane thick, or somewhat thick, firm, almost cartilaginous, collected in minute tufts, or densely interwoven in a thin or thick tomentose stratum. Cell contents oily or granulose, either red, orange, or yellow brown, growing paler after death.

[redacted]

whilst the outer ones are green. The reddish brown granules seem to be oil drops A great number of the threads terminate with a globose much thickened cell, which subsequently becomes the mother cell of the zoospores. This mother cell is rarely found in the middle of the threads. Occasionally, but still more rarely, the cell immediately under the mother cell elongates itself sideways and upwards into a thread. The mother cell of the zoospores, when it forms the terminal cell of the thread, bears a conical mass of gelatine, often of considerable size, which, however, is seldom on the crown of the cell, but usually at its side. In those mother cells in which the zoospores are about to escape a division of the contents into small oval cells is clearly perceptible, and at the side, or near the top, the wall is extended into a short papilla. The contents emerge in the form of a well defined vesicle, with the zoospores penetrating through the ruptured papilla, sometimes, however, no vesicle is formed. A few moments after emerging the vesicle bursts, doubtless by absorption of water, and the zoospores swim about in every direction. The remnants of the vesicle are of a gelatinous nature. The escape of the zoospores was observed from nine in the morning till four in the afternoon, and seems to depend not upon the influence of light, but solely upon the effect of moistening with water. The zoospores are very small, ·0035-·0033 mm. They are filled with reddish brown granular matter, the apex alone being free and hyaline; there are two cilia, about three or four times as long as the spore. The apex with the cilia is directed forwards. They rotate perpetually whilst swimming; their motion being so rapid as to prevent a clear view of them, except when stopped by some obstacle, or when their motion is becoming retarded. The cell is surrounded by a clear highly refractive border looking like gelatine, but which may be only an optical appearance. After continuing in motion for about an hour the zoospores become sluggish, sink, become globular, elongate themselves, and shortly a division of the cell takes place by a transverse septum. Some reddish brown granules usually remain behind in the empty mother cell, and in the remnant of the vesicle. Oftentimes some zoospores cannot emerge from the mother cell, and then they sometimes germinate in it. These observations were made on a variety of Chroolepus aureus. *Quart. Journ. Micro. Science*, VIII. (1860), p. 159.

Chroolepus aureus. (*Linn*). *Kutz. Tab.* IV., *t.* 93.

Golden red or orange. Threads either collected in small tufts, or spreading in a soft silky stratum, sometimes intricately and densely expanded and very much branched. Cells as long, or two to three times as long as their diameter.

SIZE. Cells ·01-·012 mm. diam. Zoosporangium ·02 × ·03 mm.

Eng. Fl. v., p. 380. Eng. Bot. ii., t. 2528. Harv. Man. 189. Mack. Hib. 246. Rab. Alg. Eur. iii., 371.

Conferva aurea, Dillw. Conf. t. 35.

Byssus aurea, Eng. Bot. i., t. 212. Lightf. Fl. Scot. p. 1002. Hull Br. Fl. 307. Relhan Cant. 446. Huds. Fl. Ang. 606. Sibth. Ox. 338. Purton Midl. Fl. ii., 606. Ray. Syn. 56, No. 6. Abbot Bedf. 276. With. Arr. iv., 144.

Ceramium aureum, Hook. Fl. Scot. ii., 86.

Amphicomum aureum, Johnst. Fl. Berw. ii., 243.

Trentepohlia aurea, Ag. Syst. p. 36.
Ectocarpus aureus, Lyngb. Hydro. Dan. t. 44. Grev. Fl. Ed. 315.

On walls, rocks, chips, bark, &c.

Plate LXXII. fig. 1. Portions of filaments × 400 *a*, zoosporangium ; *b*, zoospore ; *c*, same at rest ; *d*, germinating zoospore.

Chroolepus odoratus. (*Lyngb.*) *Ag. Syst.* 35.

Stratum thin, rather tomentose, rufous-tawny (when dry cinereous, becoming greenish). Threads and branches abbreviated, erect, parallel, flexuously curved, torulose ; cells equal or twice as long as their diameter.

Size. Cells ·02-·025 mm. diam.

Eng. Fl. v., 381. Harv. Man. 190. Rabh. Alg. Eur. iii., 372.

Conferva odorata, Lyngb. Hydr. Dan. t. 57. Johnst. Fl. Berw. ii., 245.

On the bark of various trees, especially of Birch and Poplar.

Plate LXXII. fig. 2. Portion of thread of *Chroolepus odoratus* × 400.

Chroolepus Iolithus. (*Linn.*) *Ag. Syst. p.* 34.

Stratum thin, or a line thick, reddish-orange, glaucous or dirty greenish when dry, threads and branches elongated, rather dichotomous, variously curved, ascending ; cells one and a half or three times as long as their diameter, in the upper portion of the branches reaching to double that proportion.

Chroolepus aureus, Eng. Fl. v., 380, in part.

On Holly bark.

Included in Harvey's Manual (p. 189) under *Chroolepus aureus*. Figured from the original specimen.

Plate LXXII. fig. 5. Portion of thread of *Chroolepus ilicicolus* × 400.

Chroolepus lichenicolus. *Ag. Syst.* 34.

Tufts red-orange; threads erect, tufted, alternately branched, rigid; cells slightly tumid, as long as broad.

SIZE. Cells ·012 mm. diam. Zoosporangium about ·015 mm. diam.

Eng. Fl. v., 381. Eng. Bot. ii. t., 2530. Harv. Man. 190. Mack. Hib. 247.

Conferva lichenicola, Eng. Bot. i., t. 1609. Dillw. Conf. p. 56.

Chroolepus abietinum, Rabh. Alg. Eur. iii., 372, in part.

On Lichens and old trees.

Figured from the original specimens.

Plate LXXII. fig. 3. Portion of thread of *Chroolepus abietinum*, var. *lichenicolus* × 400.

Species Excluded.

Chroolepus Arnottii. *Harv. Man. p.* 191.

This is a fungus, *Antennaria Arnottii*, Berk in Herb.

Chroolepus ebenea. *Harv. Man. p.* 189.

Conferva ebenea, Dillw. Conf. t. 101.
Byssus nigra, Eng. Bot. i., t. 702.

Probably a species of *Helminthosporium.*

Chroolepus melaenus. *Carm. in Harv. Man. p.* 189.

Conferva melaena, Lyngb. Hydrot. 57.

Apparently a *Torula.*

Chroolepus mesomelas. *Carm. in Harv. Man. p.* 189.

Torula mesomela, Carm. Alg. App.

We have seen no specimen, but it would appear from description to be *Helminthosporium.*

Family VIII. CHÆTOPHORACEÆ.

Aquatic or swamp-living algæ, rarely terrestrial, monœcious or diœcious. Articulate filaments various, often dichotomously branched, not rarely fasciculately branched, accumulated in tufts or pulvinules, nestling in a somewhat fluid or firm gelatinous mucus, or constituting, for the most part, a filamentose, rarely a somewhat foliaceous thallus (formed from a single stratum).

Propagation by oospores after sexual fecundation, or by zoogonidia; the latter produced singly, or by the division of the cytioplasm, or contents of the sporangium, into eight or sixteen.

Genus 70. MICROTHAMNION. *Nag.* (1849.)

Articulate filament dichotomously or trichotomously branched, now and then very much branched, straight, with the terminal cell obtuse, or nearly so, afterwards swollen, forming a sporangium. Cell contents effused, containing scattered amylaceous granules. Propagation by zoogonidia. Plants microscopical, more or less with a gelatinous investment.

Microthamnion vexator. *Cke. in Grevillea* XI., *p.* 75.

Filaments erect, very slender, dichotomously branched, more or less growing in tufts. Cells cylindrical, longer than broad, not at all constricted at the joints, dissepiments scarcely visible. Cell membrane thin, pellucid.

Size. Cells about ·003 mm. diam.

Propagation by oospores or zoogonidia, the latter formed by division (4-16) of the cell contents, each zoospore furnished with a red parietal spot and four vibratile cilia.

Stigeoclonium thermale. *Braun in Kutz. Spec. p.* 352.

Bright green, very much branched in a fasciculate manner, somewhat creeping at the base, filaments and branches attenuated upwards to the cuspidate apex, branchlets for the most part alternate, rather remote, nearly erect or somewhat divergent, setiform, joints variable in length, at the base of the filaments equal or twice as long as the diameter, becoming turgid, in the upper part of the branchlets 3-5 times as long as the diameter; chlorophyllose bands broad, sometimes effused.
SIZE. Cells ·012 mm.

Rabh. Alg. Eur. iii., 376. Kutz. Tab. Phyc. iii., t. 2, f. 4.
Draparnaldia elongata, Hass. Alg. 123, t. 10, f. 3. Ann. Nat. Hist. Aug. 1842, xi., p. 4.

In thermal springs, &c.

Hassall found this species on one occasion growing in a horse-trough. It is sometimes mixed with other algæ in ditches.

Plate LXXIII. fig. 2. Filament of *Stigeoclonium thermale* with zoogonidia × 400 diam.

Stigeoclonium tenue. *Ag. Syst.* 57.

Bright green, lubricous; filaments a little branched, branches nearly simple, cells equal or 2-3 times as long as their diameter, more or less distinctly constricted; chlorophyllose bands narrow; branchlets scattered, shortened, nearly erect, subulate; cells at the base longer than broad, abbreviated towards the apex.
SIZE. Cells ·01 mm. diam.

Kutz. Tab. Phyc. iii., t. 3, f. 1. Rabh. Alg. Eur. iii., 377. Kirch. Alg. Schles. p. 68.
Draparnaldia tenuis, Eng. Fl. v., 388. Eng. Bot. ii., p. 199. Harv. Man. 122. Mack. Hib. 222. Hass. Alg. 123, t. 11, f. 2.
Conferva lubrica, Dillw. Conf. t. 57. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Gray Arr. i., 303.
Conferva exigua, Dillw. Conf. t. 2 (young).

In streams and ditches.

"At first the filaments are enclosed, in the manner of a *Chætophora*, in a common, somewhat definite gelatine; afterwards, on its bursting, they issue from it like a *Conferva*, but are at all times very gelatinous." —*Harvey*.

Plate LXXIII. fig. 3. Filament of *Stigeoclonium tenue* × 400 diam.

Stigeoclonium protensum. (*Dillw.*) *Kutz. Tab. Phyc.* III., *t.* 8, *f.* 2.

Pale green, cæspitose, slender; filaments and branches long drawn out; cells almost cylindrical, equal or twice as long as their diameter; terminal cell extended into a colourless bristle; branches usually scattered, rarely in pairs, with the extremities cuspidate, piliferous.

SIZE. Cells ·015 mm. diam.

Rabh. Alg. Eur. iii., 378.

Draparnaldia condensata, Hass. Alg. 122, t. 11, f. 1. Ann. Nat. Hist. xi., 429.

Conferva protensa, Dillw. Conf. t. 67. Gray. Arr. i., 303.

In slow streams.

Plate LXXIV. fig. 1. Filament of *Stigeoclonium protensum.* *a*, zoospores × 400 diam.; *b*, branchlet of form called *S. irregulare* × 400 diam.

Stigeoclonium nanum. (*Dillw.*) *Kutz. Spec. p.* 352.

Filaments alternately branched; branches abbreviated, a little attenuated upwards, obtuse, not piliferous; cells equal or a little shorter than their diameter, in the upper part equal.

SIZE. Cells ·008 mm. diam.

Rabh. Alg. Eur. iii., 380.

Draparnaldia nana, Hass. Alg. 124, t. 10, f. 3.

Draparnaldia sparsa, Hass. Ann. Nat. Hist. xi., 428.

Conferva nana, Dillw. Conf. t. 30.

[redacted]

Stigeoclonium fastigiatum. (*Ralfs.*) *Kutz. Tab. Phyc.* III., *t.* 8, *f.* 1.

Pale green, small, thread very much branched, fastigiate, radiately disposed, mucous, upper branches alternate, fastigiate, moniliform, somewhat pinnate, a little spreading, extended at the apex in a long bristle; cells of the filament three times as long as broad, the branches equal or twice as long, swollen, constricted at the joints.

SIZE. Cells ·012 mm. diam.

Rabh. Alg. Eur. iii., 380.

Chætophora fastigiata, Ralfs. Alg. Exs., No. 9.

Attached to aquatic plants.

Plate LXXIV. fig. 3. Filament of *Stigeoclonium fastigiatum* × 400 diam.

GENUS 72. **DRAPARNALDIA.** *Ag.* (1824.)

Articulate thread simply branched, formed of large cells, for the most part hyaline, with a broad chlorophyllose band, always sterile; more or less densely furnished with penicellate fasciculate branchlets, alternate or opposite, composed of smaller fertile cells. Terminal cells of all the branches empty, hyaline and sterile, more or less elongated into a bristle.

Propagation by resting spores or zoogonidia.

Draparnaldia glomerata. *Ag. Syst. p.* 59.

Filaments and primary branches colourless, or nearly so; lower cells equal, or a little shorter than their diameter, distinctly constricted at the joints; chlorophyllose bands narrow, pale green, primary branches spreading at right angles, sometimes opposite; fascicles of the branches crowded, alternate or opposite, densely branched, obtuse, oval.

SIZE. Cells of main thread ·035 mm., of fascicles ·008 mm.

Eng. Fl. v., 388. Jenner Tunb. Wells 176. Eng. Bot. ii., t. 2545. Harv. Man. 121. Grev. Fl. Ed. 321. Mack. Hib. 222. Flor. Dev. ii., 50. Hook. Fl. Scot. ii., 77. Gray. Arr. i., 302. Hass. Alg. 120, t. 13, f. 1. Rabh. Alg. Eur. iii., 381. Kirch. Alg. Schles. p. 67. Kutz. Tab. Phyc. iii., t. 12.

Conferva mutabilis, Dillw. Conf. t. 12. Eng. Bot. i., t. 1746.

Batrachospermum conglomeratum, Vauch. Conf. t. 12, f. 1.

In clear pools or slow streams.

Very common, and well known. Variable in the size, number, and disposition of the fascicles.

Plate LXXV. fig. 1. Portion of filament of ***Draparnaldia glomerata*** × 400 diam. Fig. 2, portion of filament of the variety ***distans*** × 400 diam.

In 1857 Dr. Braxton Hicks first described in the "Journal of the Linnean Society" (Vol. i., p. 192) what he believed to be a new species of *Draparnaldia* under the name of ***Draparnaldia cruciata***, of which we know nothing except from his description and figures, from which we are disposed to regard it as a variety of ***Draparnaldia glomerata***. It was first found in the New Forest, and was more fully illustrated in the "Quarterly Journal of Microscopical Science" (Vol. ix., 1869, p. 383, pl. xix.). "Nothing," he says, "is more remarkable than the direction taken by the branches, which diverge strictly at right angles to the stem. Even the lesser kind, called tufts, and their branchlets, pass off in this way, and as four generally spring from the same joint, there is a cruciate arrangement in every part."

The following is given as its description:—"Frond 3-4 inches long. Light green colour, not so green as *D. glomerata* and *D. plumosa*, possessing a flocculent appearance when in water, and highly mucous when out of water. Every portion is surrounded by a distinct layer of transparent mucous, extending on each side to the distance of three diameters of the included ramulus. This is most easily seen after two days, when extraneous matter adheres to the mucous. The main filament is composed of cells very slightly inflated, 3-4 times longer than wide, about $\frac{1}{330}$th of an inch wide, delicately fasciated. Primary ramuli proceeding at right angles, chiefly in whorls of four, from the main filament, with an interval of 50-60 cells. The sub-ramuli also proceed in the same way from the primary ramuli, giving the plant a cruciate appearance. The cells of the ramuli as wide as long, the larger fasciated, the smaller quite filled with green chlorophyll. The interspace of 50-60 cells of main filament being great, to the naked eye it appears nearly bare, but by higher magnifying powers small tufts, like those terminating the sub-ramuli, appear at about every ten cells; some larger, and approaching somewhat the sub-ramuli, while the others are very simple. The larger terminal and lateral

[redacted]

Draparnaldia plumosa. (*Vauch.*) *Ag. Syst. p.* 58.

Threads and primary branches hyaline, cells equal or shorter than their diameter, rarely a little longer, a little, or but scarcely constricted at the joints, chlorophyllose bands narrow, bright green, lower cells of the branches equal or almost twice as long as their diameter, upper cells cylindrical, attenuated, 2-5 times as long as broad, sometimes not piliferous, fascicles of the branches densely branched, elongated, with an acutely lanceolate outline, erect, somewhat appressed.

SIZE. Cells of main thread ·045 mm., of fascicles ·008 mm.

Eng. Fl. v., 388. Eng. Bot. ii., t. 2544. Harv. Man. 121. Johnst. Fl. Berw. ii., 258. Mack. Hib. 222. Flor. Dev. ii., 50. Hook. Fl. Scot. ii., 77. Gray Arr. i., 303. Hass. Alg. 121, t. 12, f. 1. Rab. Alg. Eur. iii., 382. Kirch. Alg. Schles. p. 67. Kutz. Tab. Phyc. iii., t. 14.

Conferva lubrica, Eng. Bot. i., t. 2087.

In slow streams or pools.

Much less common than the preceding species.

Plate LXXVI. fig. 1. Portion of filament of *Draparnaldia plumosa*, × 400. *Fig.* 2. Portion of filament of the variety *pulchella* × 400.

GENUS 73. **CHÆTOPHORA.** *Schrank.* (1789.)

Articulate filaments, with the primary branches radiately disposed, composed of elongated vegetative cells, with chlorophyll bands as in *Draparnaldia* and *Stigeoclonium;* divided upwards into numerous branchlets, which are shortly artoculated, the ultimate joint attenuated, often empty, scarcely or not at all lengthened into a thread, ultimate branchlets in more or less crowded fascicles, involved in a firm gelatinous, coriaceous, or hard mass, of a globose or subglobose, or plane, expanded, variously lobed form. Propagation the same as in the preceding genera.

Chætophora pisiformis. (*Roth.*) *Ag. Syst. p.* 27.

Thallus globose, about the size of a pea, often smaller (now and then as large as a cherry), bright green, even, shining, sometimes aggregated, not rarely confluent.

SIZE. Cells ·006-·009 mm., of branches ·006 mm.

Hass. Alg. 128, t. ix., f. 5, 6. Kutz. Tab. Phy. iii., t. 18, fig. 3. Grev. Sc. Crypt. Fl., t. 150. Rabh. Alg. Eur. iii., 383. Kirch. Alg. Schl. p. 69. Eng. Fl. v., 389. Harv. Man. 123. Berk. Glean. t. 1, f. 1.

Ulva pisiformis, Huds. Fl. Ang. 572. With Arr., iv. 120.
Chætophora elegans, Lyngb. Hydro. t. 65.

On submerged plants.

Plate LXXVII. fig. 1. Plants of *Chætophora pisiformis*, natural size, and filaments × 400.

Chætophora tuberculosa. (*Roth.*) *Ag. Syst.*

Thallus subglobose, the size of a cherry, bright or pale green, surface tuberculose, elastic, fascicles of branches very dense, lower articulations cylindrical, the upper swollen, extremities cuspidate, sharp pointed, rarely hair-like.
SIZE. Cells ·009-·012 mm., of branches ·008-·01 mm.

Harv. Man. p. 122. Hass. Alg. 126, t. 9, f. 7, 8. Kutz. Tab. Phyc. iii., t. 19, f. 1. Rabh. Alg. Eur. iii., 383. Eng. Fl. v., 389. Jenner Tunb. Wells p. 178. Eng. Bot. ii., t. 2547. Johnst. Fl. Berw. ii., 260. Mack. Hib. 223. Hook. Scot. ii., 76. Kirch. Alg. Schles. p. 69.
Rivularia tuberculosa, Eng. Bot. i., 2366.

In clear water.

Plate LXXVIII. fig. 1. *a*, plant of *Chætophora tuberculosa*, natural size. *b*, filaments of same × 400 diam.

Chætophora elegans. (*Roth.*) *Ag. Syst.*

Thallus the size of a pea or a cherry, pale green, surface even, elastic, soft, now and then becoming hard, fascicles of branches lax, rather flaccid, extremities shortly cuspidate, often terminating in a hair.
SIZE. Cells ·007-·009 mm., of branches ·005-·007 mm.

[redacted]

fascicles of branches lateral, more or less dense, spreading articulations more or less swollen, nearly equal in length and diameter, constricted at the joints, cell contents granulose, effused.

SIZE. Cells ·01-·015 mm., of branches ·008-·011 mm.

Kutz. Tab. Phy. iii., t. 21, f. 2. Rabh. Alg. Eur. iii., 385. Kirch. Alg. Schl. p. 70. Eng. Fl. v., 389. Eng. Bot. ii., t. 2546. Harv. Man. p. 122. Johnst. Fl. Berw. ii., 261. Mack. Hib. p. 222. Hook. Fl. Scot. ii., p. 76. Hass. Alg. 125, t. 9, f. 1, 2.

Batrachospermum fasciculatum, Vauch. Conf. p. 116, t. 13.

Ulva incrassata, Eng. Bot. i., t. 967. Huds. Fl. Ang. ii., 572. With. Arr. iv., 124.

Conferva gelatinosa Damæ cornu, Ray Syn. p. 60.

Tremella gelatinosa Dama cornuum, Dill. Musc. 51, t. 10, f. 10.

Rivularia incrassata, Purton Mid. Fl. iii., p. 179.

Myriodactylon endivæfolium, Gray Arr. i., 302.

In ditches, &c.

Exceedingly variable in the form of the thallus, and hence divided into 7 or 8 varieties.

Plate LXXVIII. fig. 2. *a*, plants of *Chætophora endivæfolia*, natural size. *b*, portion of filament × 400 diam.

Chætophora punctiformis. *Kutz. Tab. Phyc. iv., p.* 4, *t.* 18, *f.* 2.

Echinella articulata, Eng. Bot. ii., t. 2555.

Conferva echinata, Eng. Bot. i., t. 1378.

Assuming that Mr. W. Phillips (Grevillea ix., p. 5) is correct in the presence of globose basal spores, this will have to find a place in *Rivularia*, and not in *Chætophora*.

GENUS 74. **COLEOCHÆTE.** *Bréb.* (1844.)

Articulated filaments branched, either united in a pulvinule, or little cushion, or expanded in a flat, somewhat disc-shaped parenchymatous thallus ; cells oblong, more or less dilated in front, sometimes bearing from the back or upper surface a hyaline bristle, which is sheathed at its base.

Propagation by oospores resulting from sexual fertilization, and by zoogonidia. Zoogonidia single in the fructiferous cells, either globose or broadly oval, furnished with two vibratile cilia.

The Coleochæteæ are small discoid Algæ, from 1 to 2 mm. in diam., bright green colour, constructed of branched rows of cells. They are found attached to submerged plants in stagnant or slow-moving streams, and form circular, closely-pressed discs. The chlorophyll is in parietal plates or large granules. Some of the cells bear colourless erect bristles fixed at the base in narrow sheaths.

Reproduction takes place by means of asexual zoogonidia, and sexually produced oospores. The latter do not at once produce new plants, but several zoospores. The zoospores, which are developed in the early part of the year from resting-spores of the previous year, produce only asexual plants which only form zoogonidia. After a series of asexual generations, of variable length, a sexual generation arises, which according to the species is monœcious or diœcious. Fertilization produces one oospore in the oogonium, which developes into a reproductive body, from the cells of which zoospores proceed in the next period of vegetation. Zoogonidia may originate in all the vegetative cells of the Coleochæteæ, and are always formed from the entire contents of the mother-cell, escaping through a round hole in the cell wall.

"In *C. pulvinata* the terminal cell of a branch swells up, and at the same time elongates into a narrow sac, which then opens, and exudes a colourless mucilage. The protoplasm of the swollen part, which contains chlorophyll, forms the oospore, in which a nucleus is visible. The antheridia are formed at the same time in adjoining cells, two or three protuberances growing out, which become separated by septa; each of the cells thus formed, which have somewhat the shape of a flask, is an antheridium; its entire contents form an antherozoid of oval shape with 2 cilia, which is endowed with motion like a zoogonidium; its entrance into the oogonium has not yet been observed. The effect of a fertilization is seen in that the contents of the carpogonium become surrounded with a proper membrane and form the oospore."

Coleochæte soluta. *Prings. Jahrb. t.* 1, *f.* 2.

Threads radiating from a common centre, furcately branched, of equal length, closely packed side by side, prostrate, but not connate, forming an orbicular disc. Cells one and a-half to three times as long as broad, oogonia placed before the terminal cells, globose, corticate.

SIZE. Cells ·025 mm.

Rabh. Alg. Eur. iii., 389. Kirch. Alg. Schles. p. 50.

Attached to aquatic plants.

Coleochæte orbicularis. *Prings. Jahrb. t.* 1, *f.* 5.

Disc orbicular, parenchymatous, formed from one stratum of cells, bright green, cells oblong-quadrangular when old, by pressure becoming often polygonal, usually twice as long as broad. Oogonia oval, peripherical, mostly naked.

SIZE. Cells ·012-·017 mm.

Rabh. Alg. Eur. iii., 390. Kirch. Alg. Schles. p. 50.

Phyllactidium pulchellum, Kutz. Tab. Phyc. iv.

On aquatic plants.

Plate LXXX. fig. 1. *a*, plant × 200. *b*, portion with oogonia, after Pringsheim × 250.

GENUS 75. **APHANOCHÆTE.** *Braun.* (1847.)

Articulate threads prostrate, somewhat creeping, sometimes more or less united in an irregular stratum. Branches decumbent or ascending, cells bearing on their apex or back, often a long bristle which has no sheath at the base. Propagation by zoogonidia. Oogonia at present unknown.

Aphanochæte repens. *Braun Rejuv. p.* 184.

Filaments and branches procumbent, adpressed; cells slightly swollen, of equal diameter in both directions, supporting an indistinctly articulated bristle.

SIZE. Cells ·005-·01 mm.

Rabh. Alg. Eur. iii., 391. Kirch. Alg. Schles. p. 71.

On *Cladophora flavescens*, and other Algæ.

Plate LXXX. fig. 3. Plant of *Aphanochæte repens* × 400.

Aphanochæte hystrix. (*Thw.*) *Rabh. Alg. Eur.* III. 391.

Filaments and their branches radiating, procumbent, adpressed; more or less connate, in a pale green irregular discoid thallus. Cells somewhat cylindrical, produced at the apex into a long bristle, which is not articulated.

SIZE. Cells ·01 mm. diam.

Ochlochæte hystrix, Thwaites in Harv. Phyc. Britt. t. 226.

On aquatic plants in brackish ditches.

Perhaps scarcely deserving a place here, as it is almost, if not quite, a marine species.

Plate LXXX. fig. 2. *a*, plant of *Aphanochæte hystrix*, slightly magnified. *b*, portion more highly magnified, after Harvey.

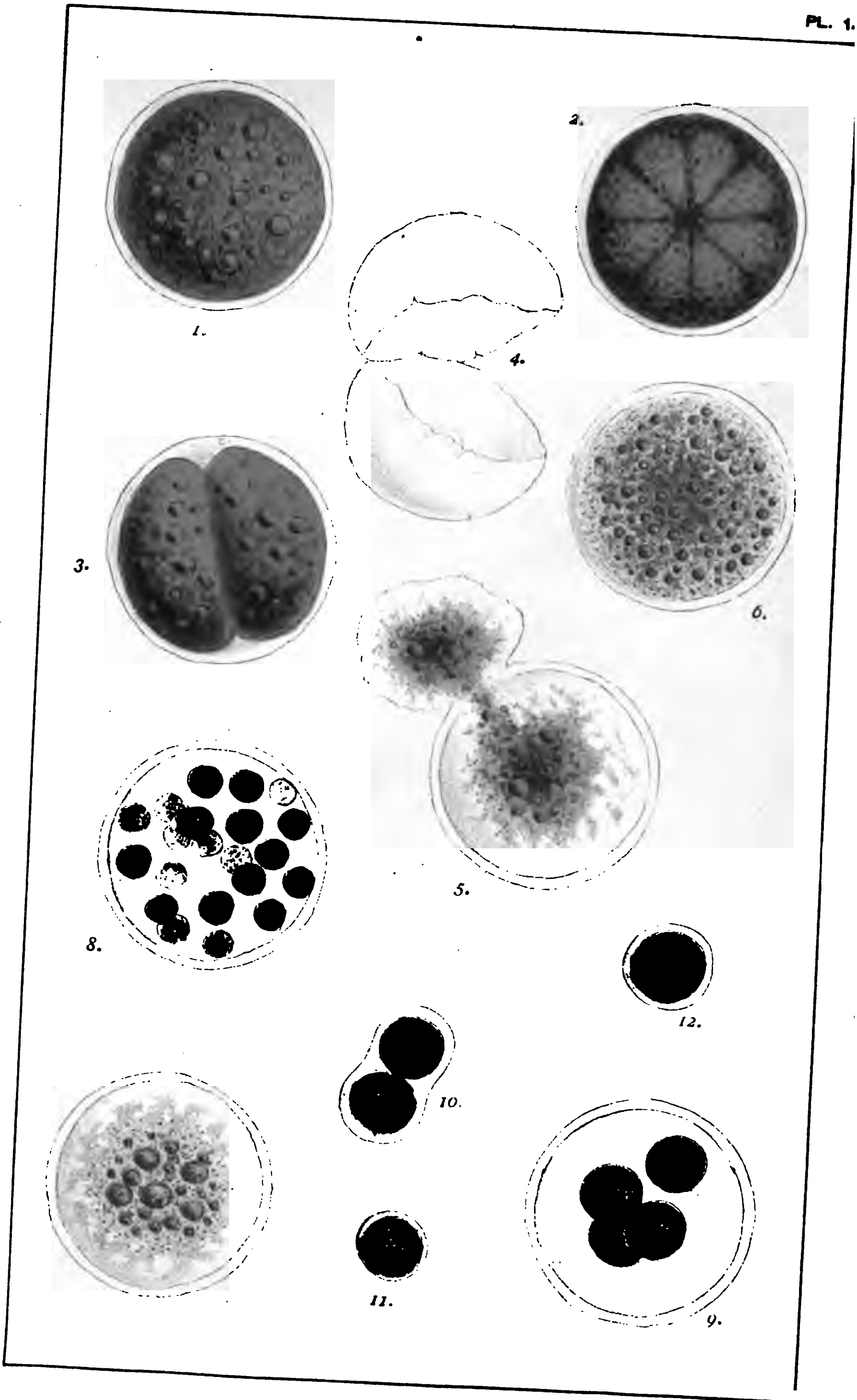
APPENDIX

TO CHLOROPHYLLOPHYCEÆ.

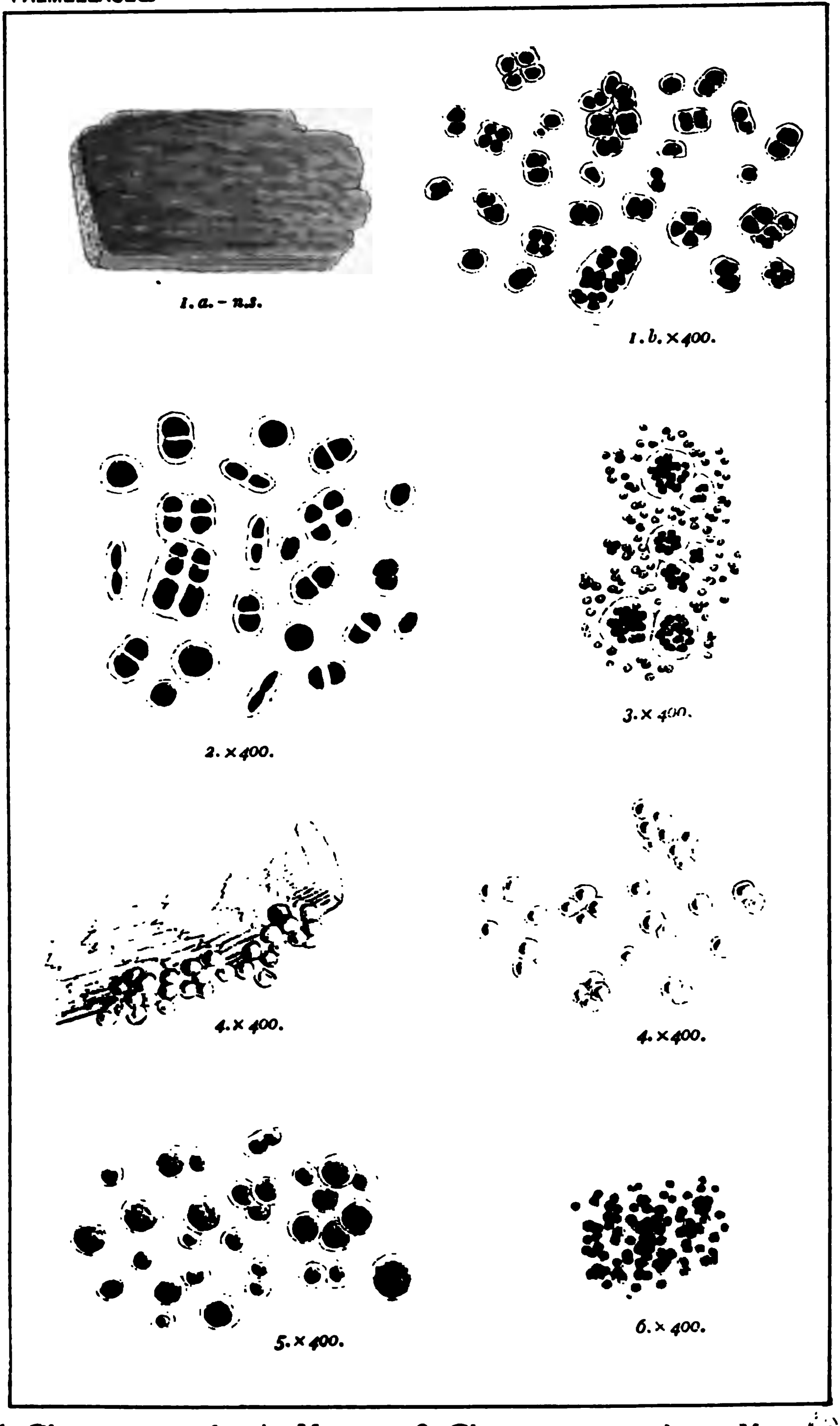
In the form of an Appendix we shall here enumerate a few species, of doubtful position, which are not known with sufficient exactitude to be recorded in systematic order, although their affinities appear to be with the Algæ. The *Saprolegnieæ* are not included, because they are now generally acknowledged as Fungi. The genus *Synchitrium* also appears to be more nearly related to *Protomyces*, amongst Fungi, than to Algæ.

FAMILY. CHYTRIDIEÆ.

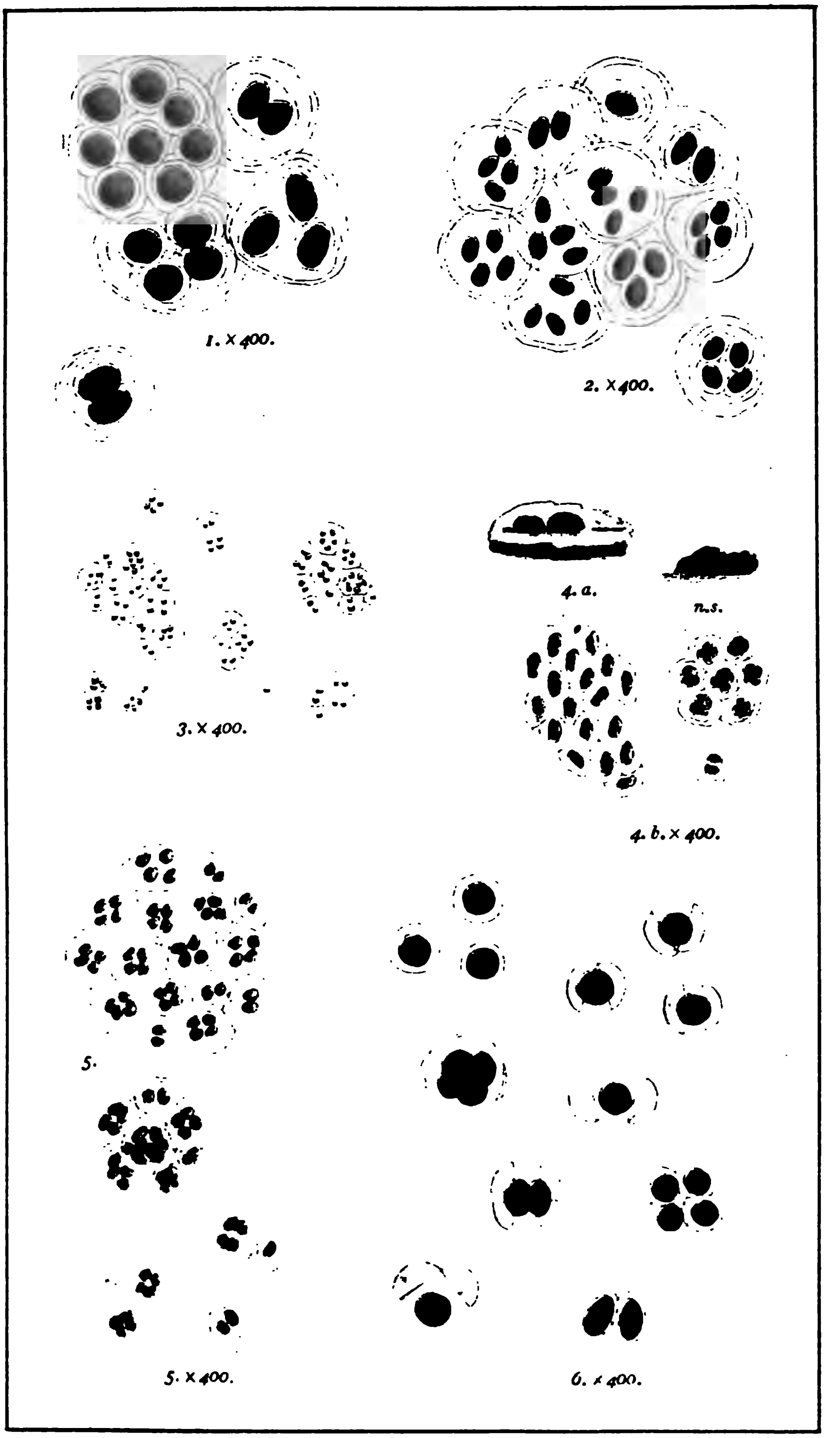
Plants for the most part aquatic, parasitic, epiphytal or endophytal, occasionally epizoic, very rarely terrestrial, one or two-celled. Cells vesiculose, single or gregarious, either innate in the fostering plant, or penetrating its membrane; furnished with radicles at the base, or destitute of them; now and then numerous and densely aggregated, involved in a common membrane, nestling in the parenchyma of terrestrial plants, and form- [redacted]



Eremosphæra viridis. (D)By.



1. *Pleurococcus vulgaris. Men.* 2. *Pleurococcus angulosus. Men.*
3. *Pleurococcus mucosus. Kutz.* 4. Pleurococcus Beigelii. Kuch.
5 *Pleurococcus miniatus. Kutz.* 6. Pleurococcus roseo-persicinus.



1. *Glæocystis ampla. Kutz.*
2. *Glæocystis vesiculosa. Nag.*
3. *Glæocystis botryoides. Kutz.*
4. *Glæocystis adnata. Huds.*
5. *Glæocystis Paroliniana. Nag.*
6. *Schizochlamys gelatinosa. Br.*

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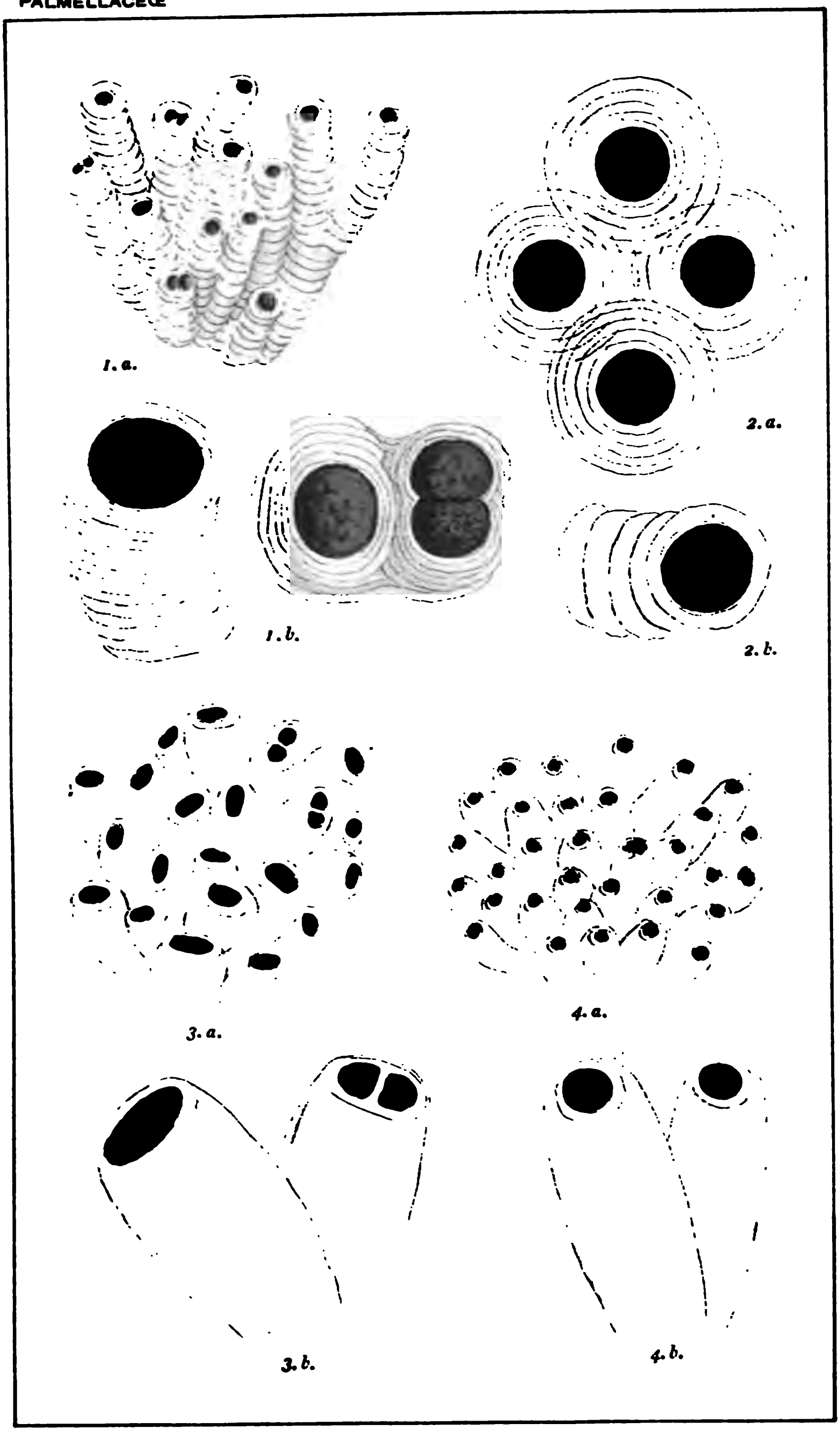
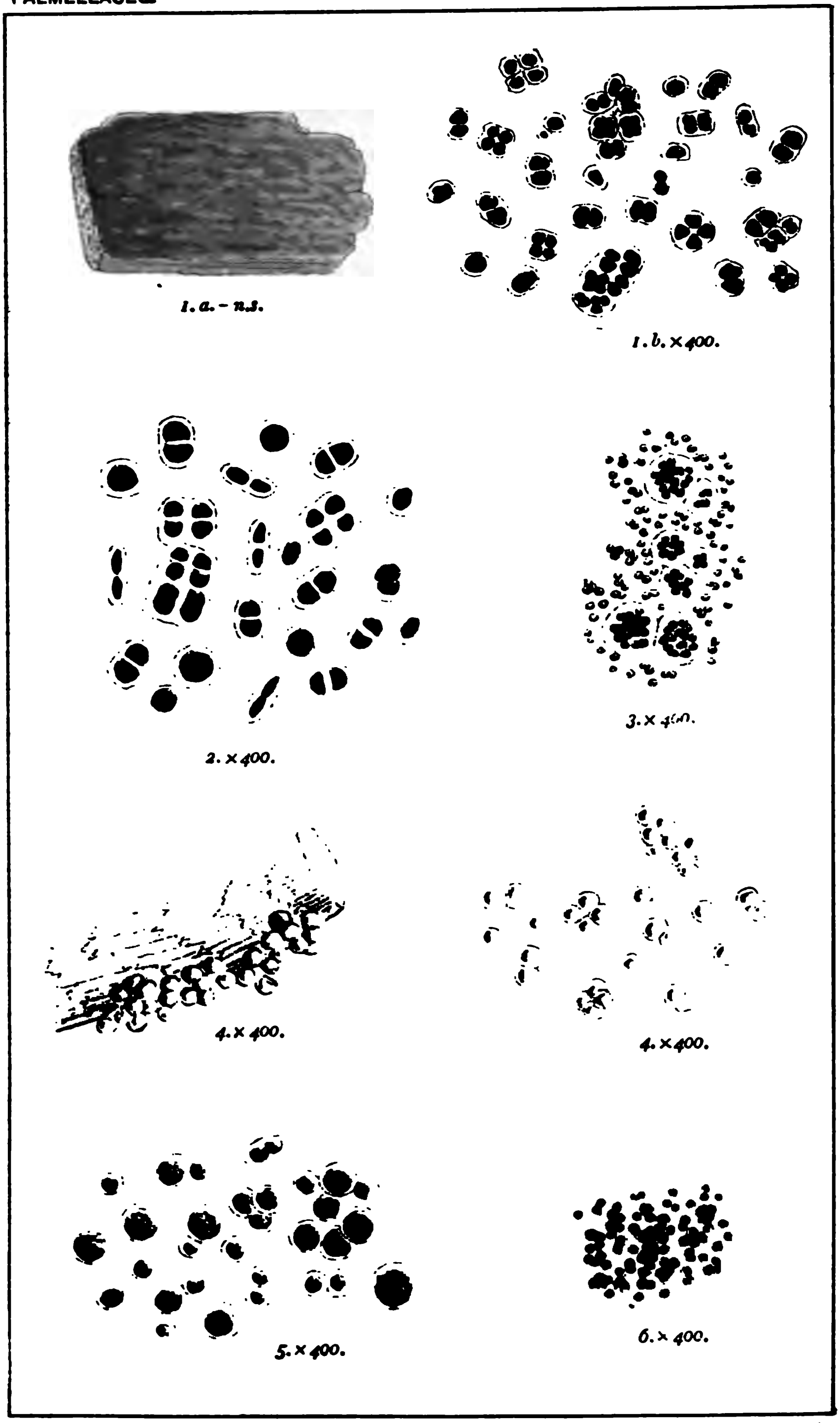


1. *Urococcus Hookerianus, Hass.* 2. *Urococcus insignis Hass.*
3. *Urococcus Allmanni Hass.* 4. *Urococcus cryptophilus. Hass.*



1. *Pleurococcus vulgaris. Men.*
2. *Pleurococcus angulosus. Men.*
3. *Pleurococcus mucosus. Kutz.*
4. *Pleurococcus Beigelii. Kuch.*
5. *Pleurococcus miniatus. Kutz.*
6. *Pleurococcus roseo-persicinus. K*

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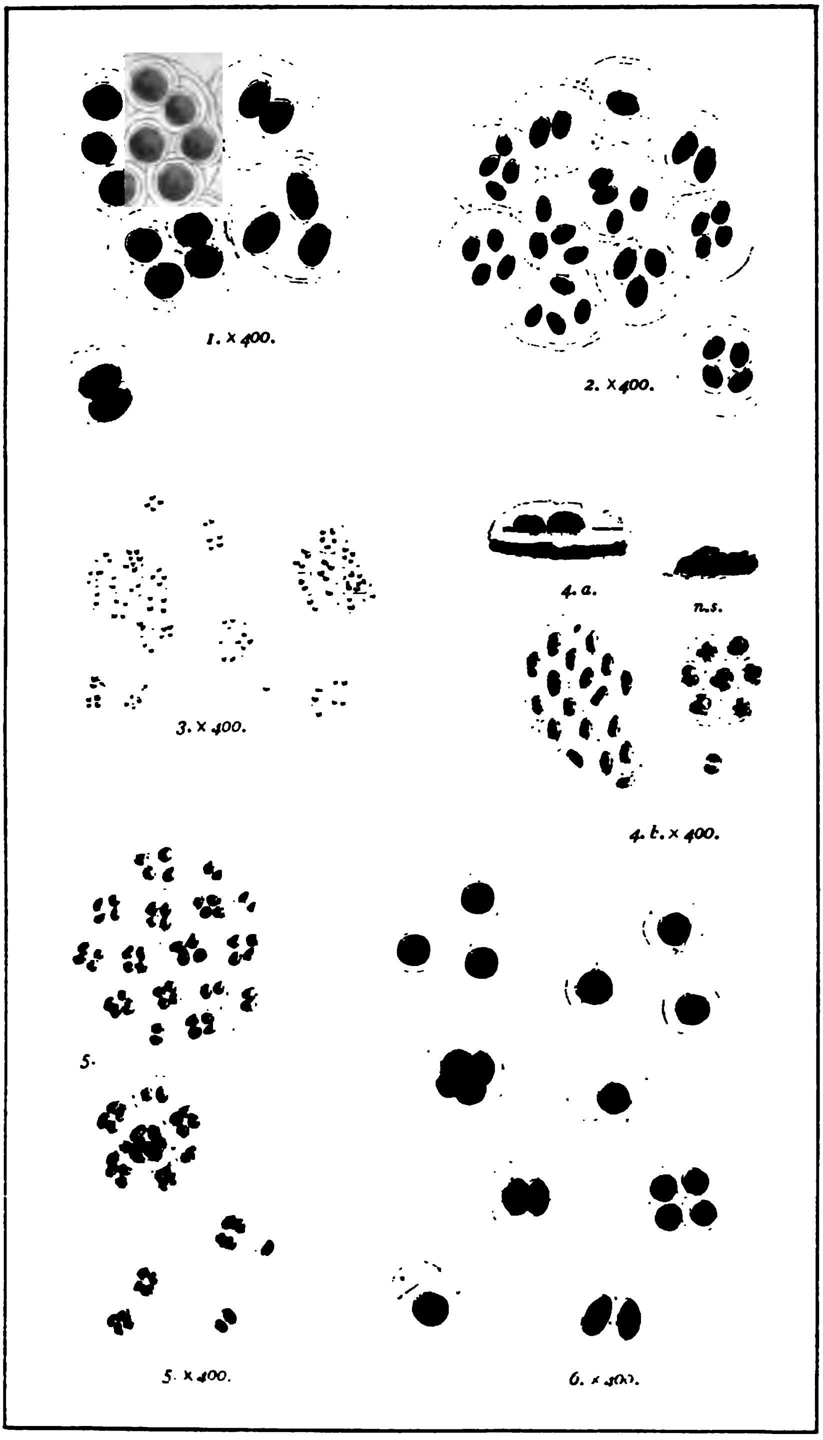
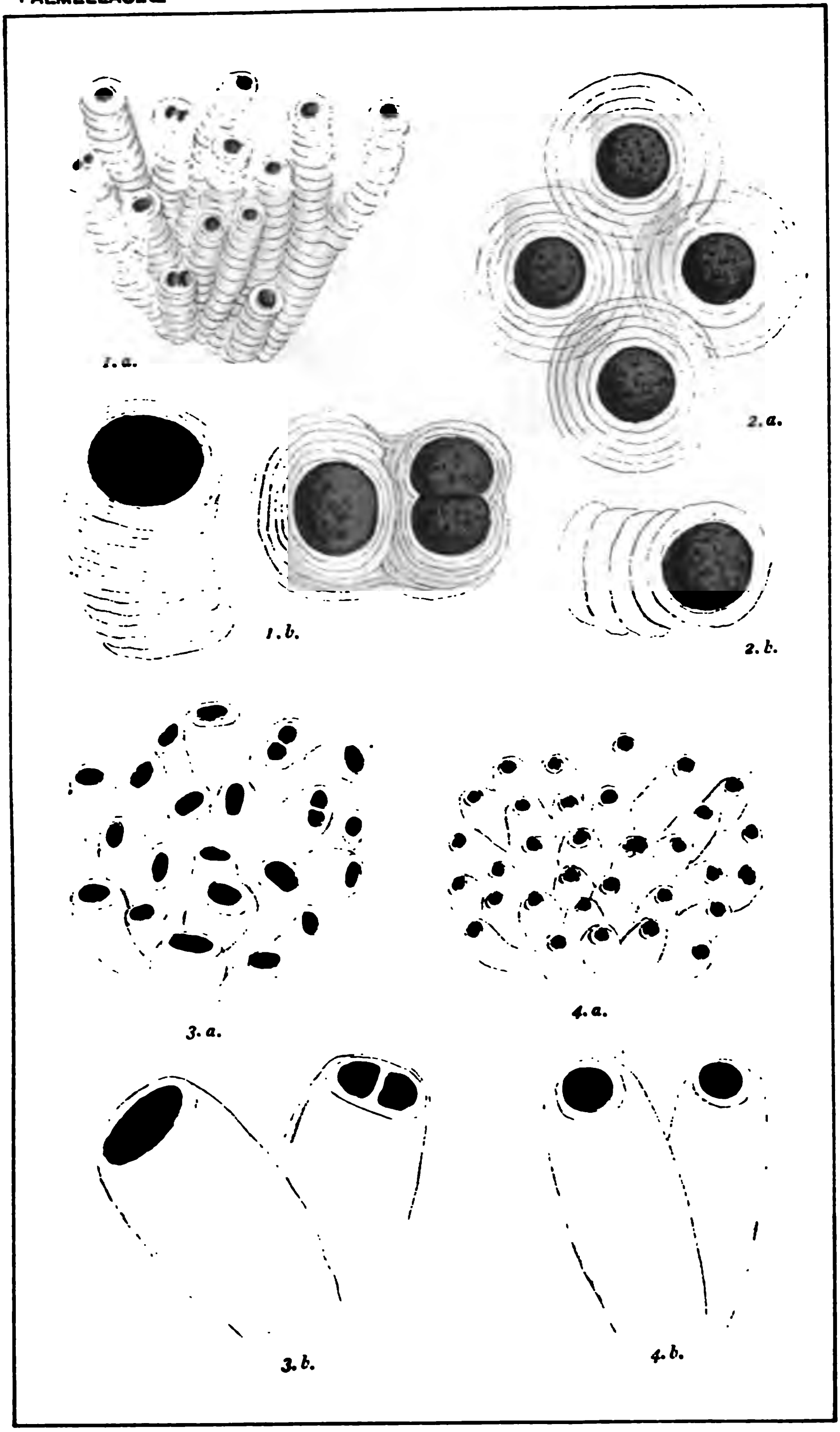
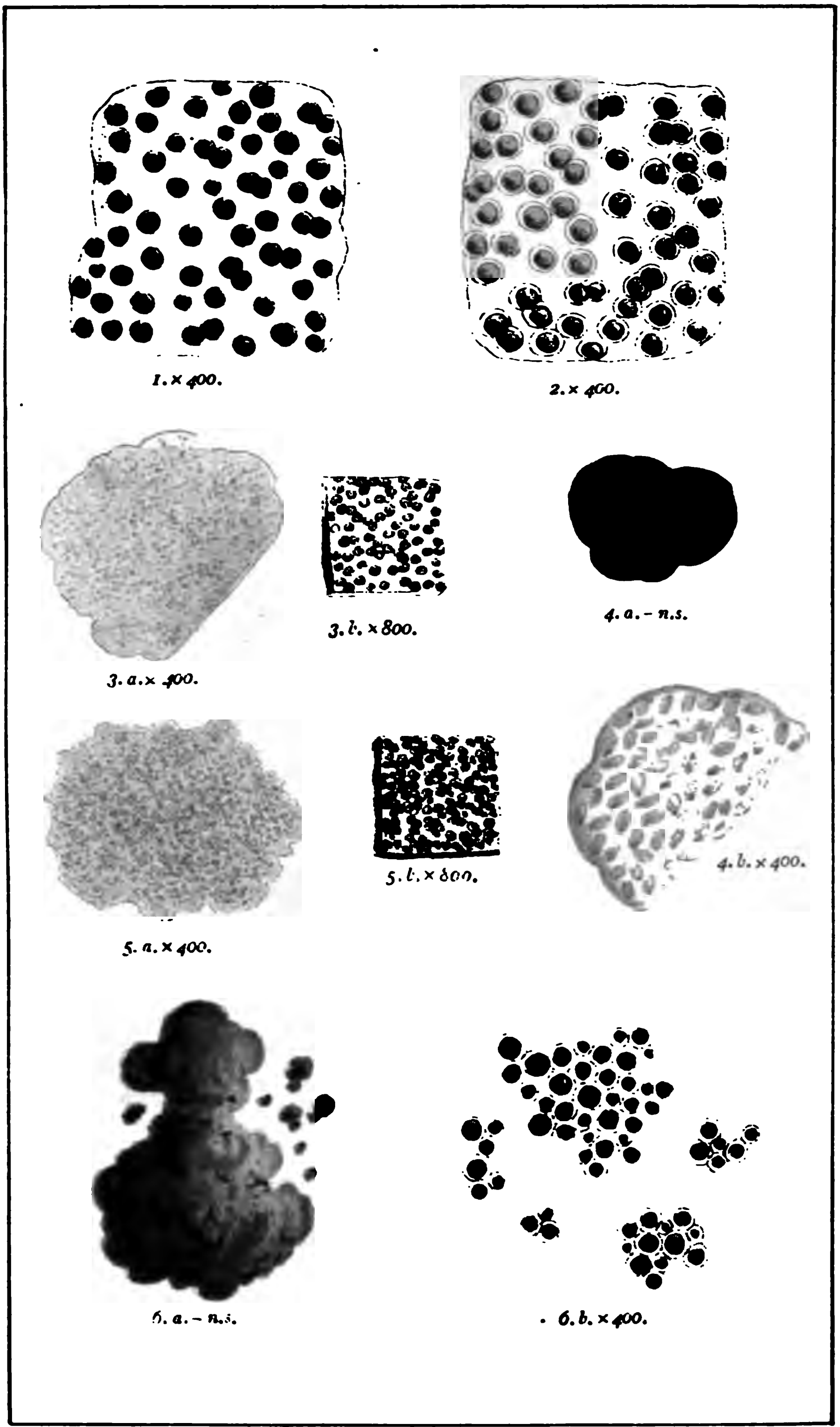


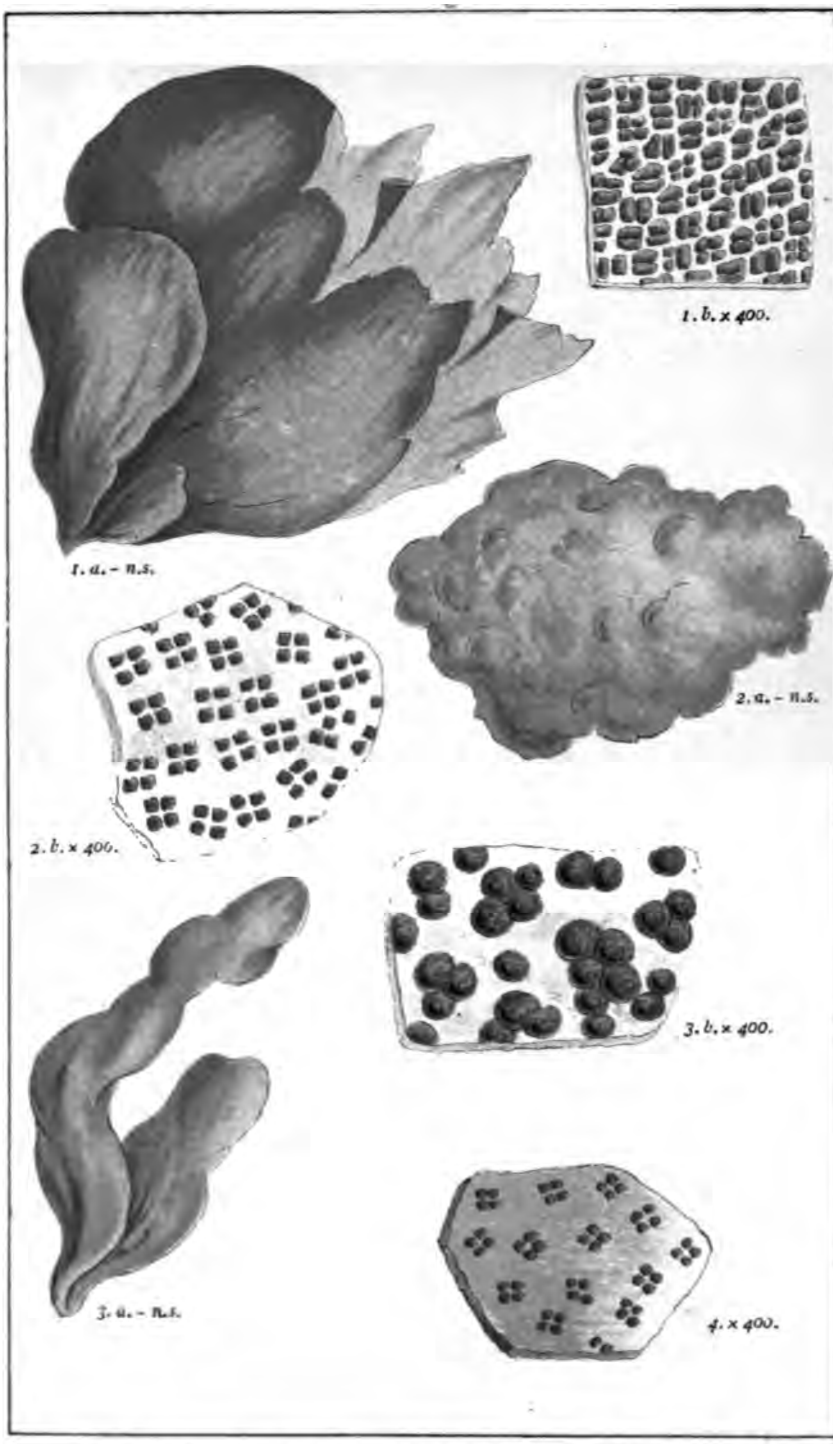
1. *Glœocystis ampla.* Kutz.
2. *Glœocystis vesiculosa.* Nag.
3. *Glœocystis botryoides.* Kutz.
4. *Glœocystis adnata.* Huds.
5. *Glœocystis Paroliniana.* Nag.
6. *Schizochlamys gelatinosa.* Br



1. *Urococcus Hookerianus, Hass.* 2. *Urococcus insignis Hass.*
3. *Urococcus Allmanni Hass.* 4. *Urococcus cryptophilus. Hass.*



1. *Palmella mucosa. Kutz.*
2. *Palmella miniata. v. æqualis. Nag.*
3. *Palmella hyalina. Breb.*
4. *Palmella Mooreana. Harv.*
5. *Palmella prodigiosa. Mont.*
6. *Porphyridium cruentum. Ag.*



1. Tetraspora bullosa Ag. 2. Tetraspora gelatinosa Desv.
3. Tetraspora lubrica Ag. 4. Tetraspora flava Hass.

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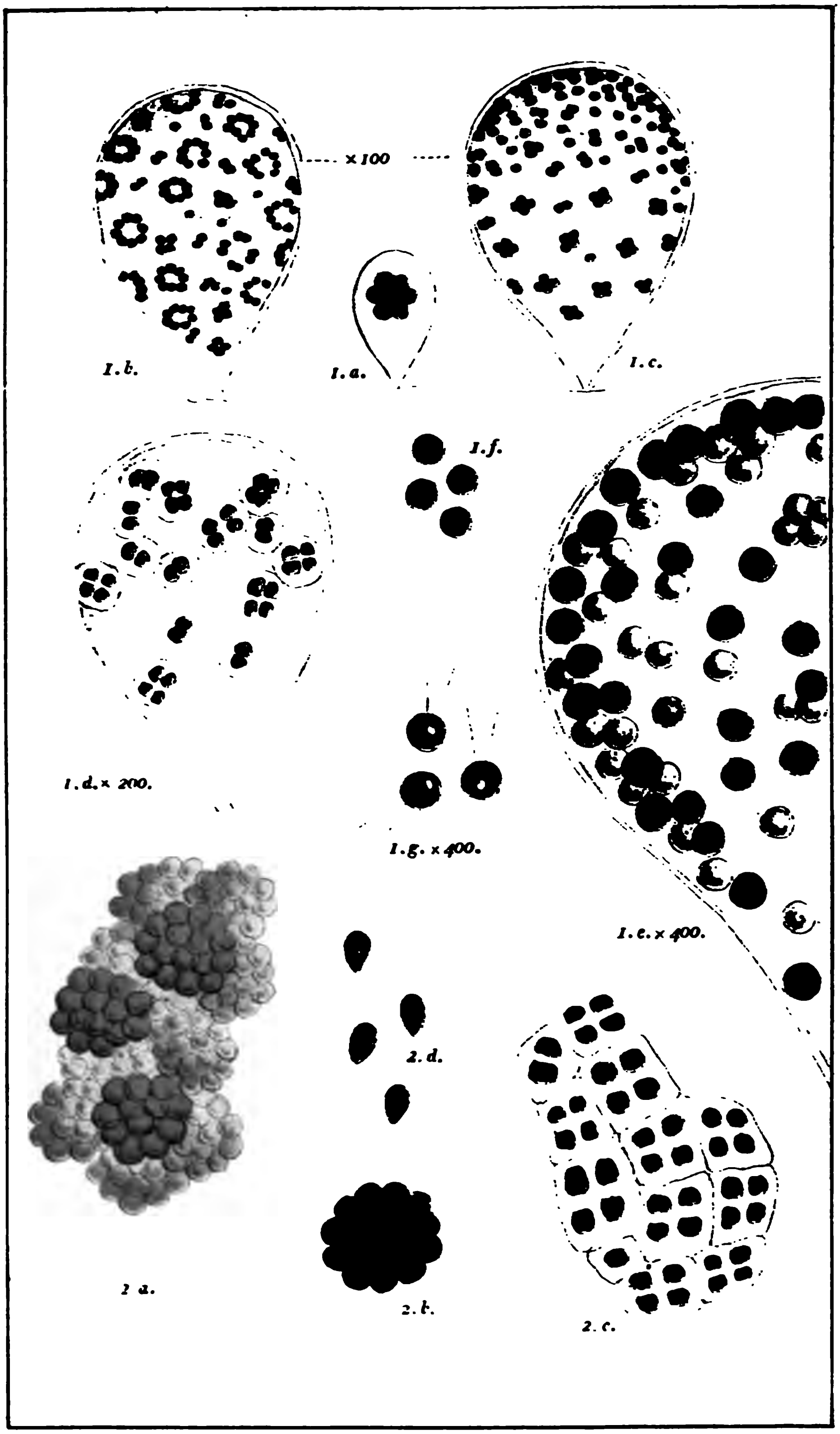
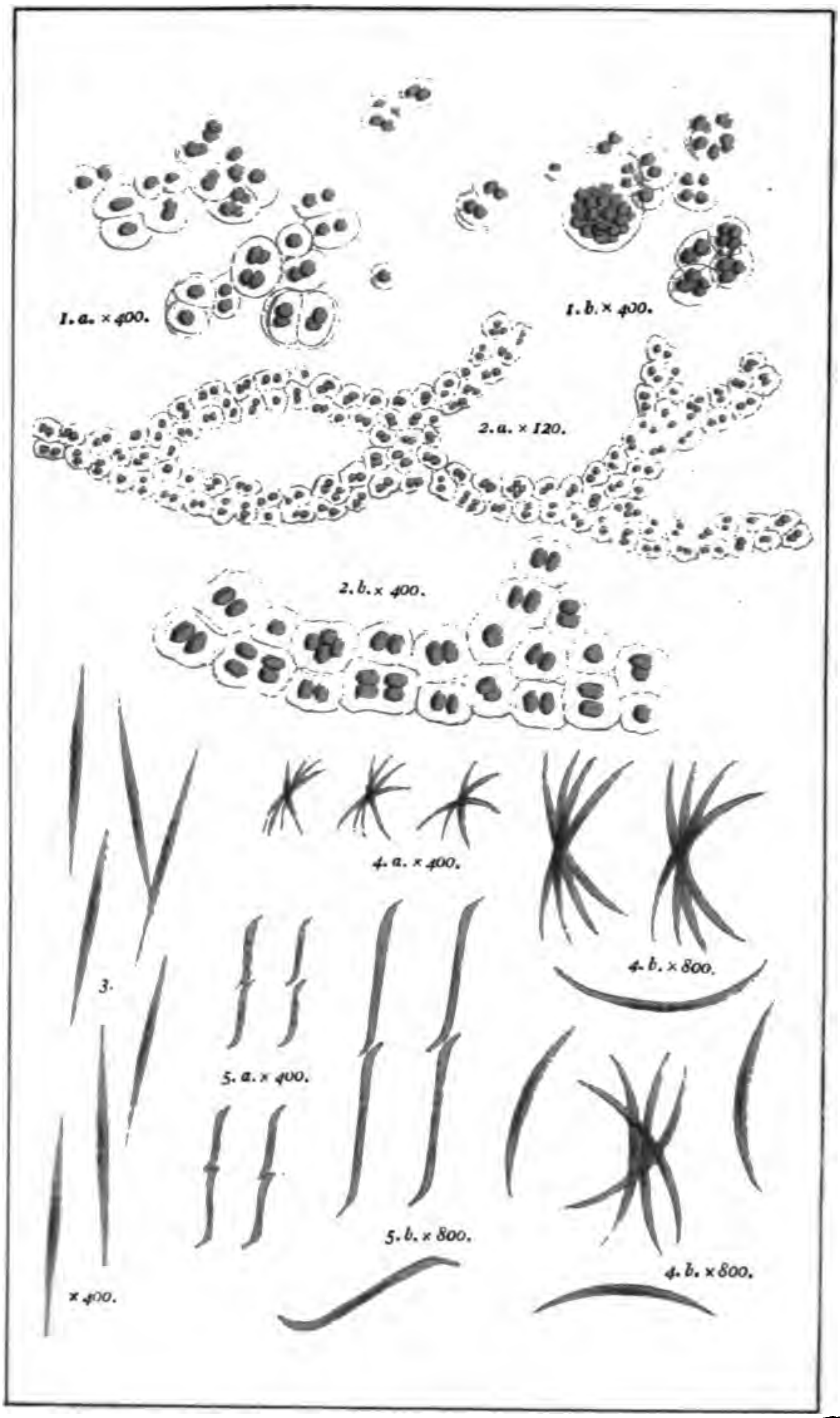
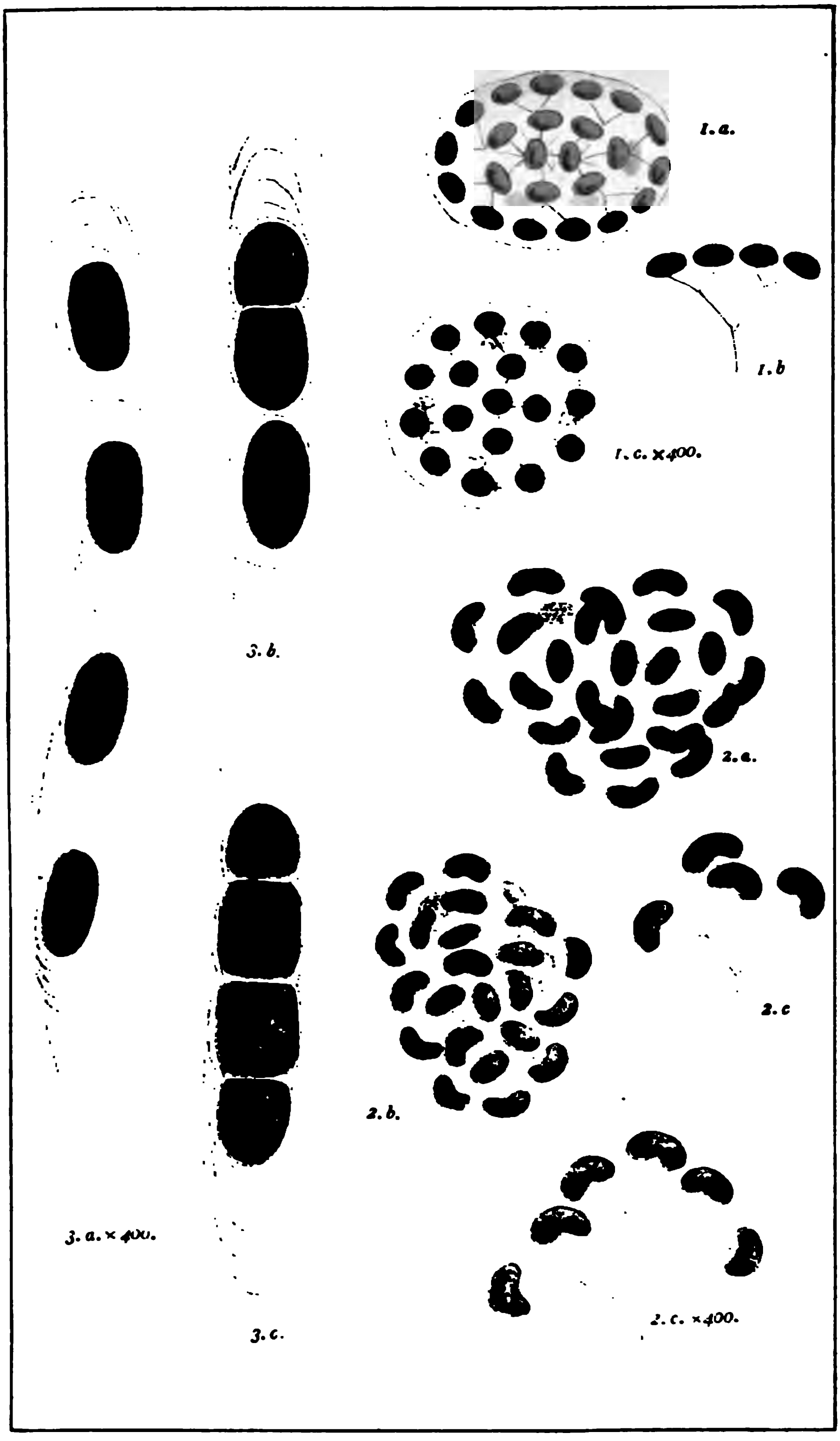


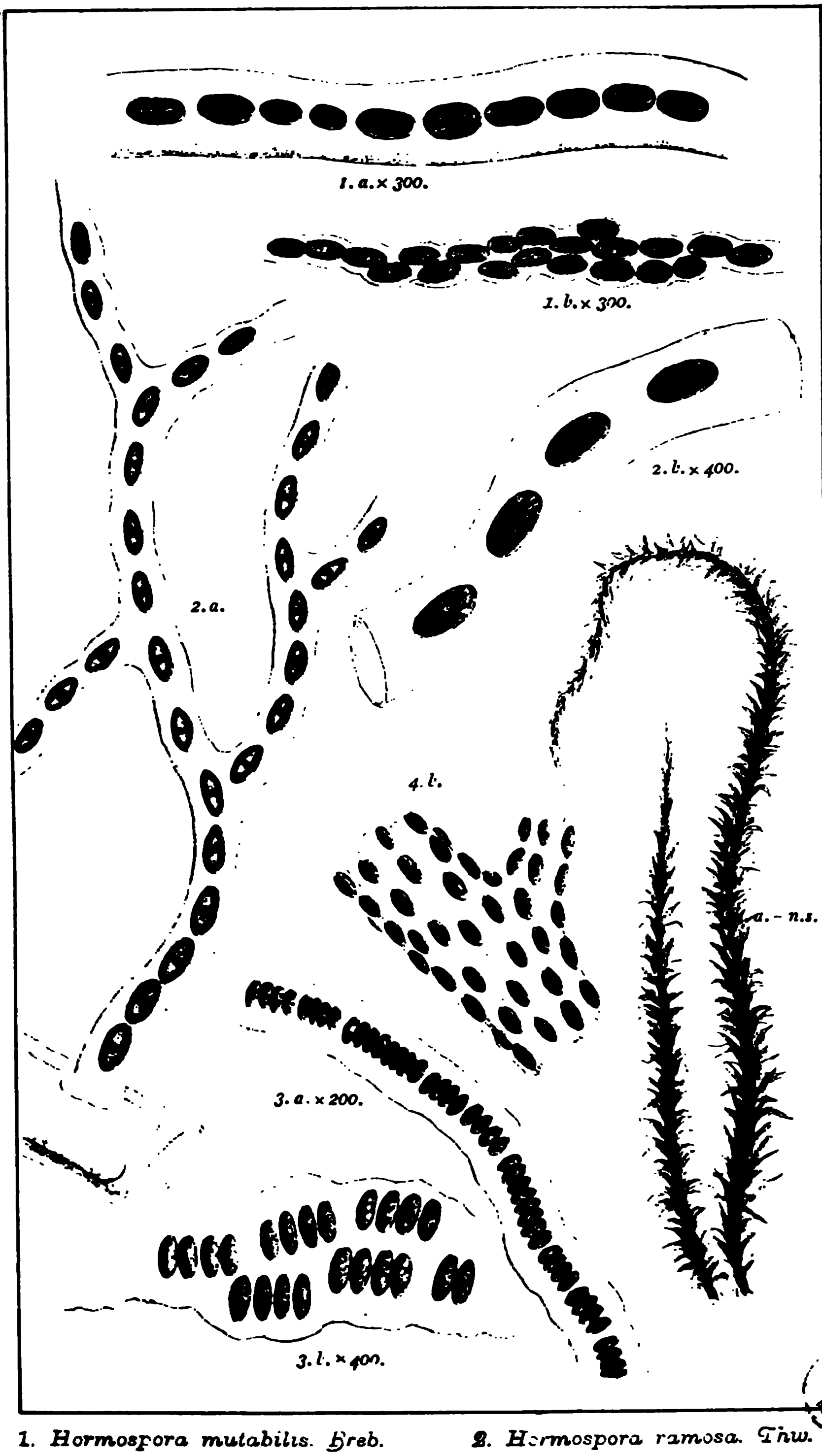
1. Apiocystis Brauniana. Näg. 2. Botryococcus Braunii. Kutz.



1. *Glœocystis rupestris. Lyng.* 2. *Palmodictyon viride. Kutz.*
3. *Rhaphidium aciculare Br.* 4. *Rhaphidium falcatum. Rabh.*
5. *Rhaphidium* duplex. Kutz.



1. *Dictyosphærium Ehrenbergianum.* Näg.
2. *Dictyosphærium reniforme.* Buln.
3. *Cylindrocapsa involuta.* Reinsch.



1. *Hormospora mutabilis.* Breb. 2. *Hormospora ramosa.* Thw.
3. *Hormospora transversalis.* Breb. 4. *Hydrurus penicillatus.* Ag.

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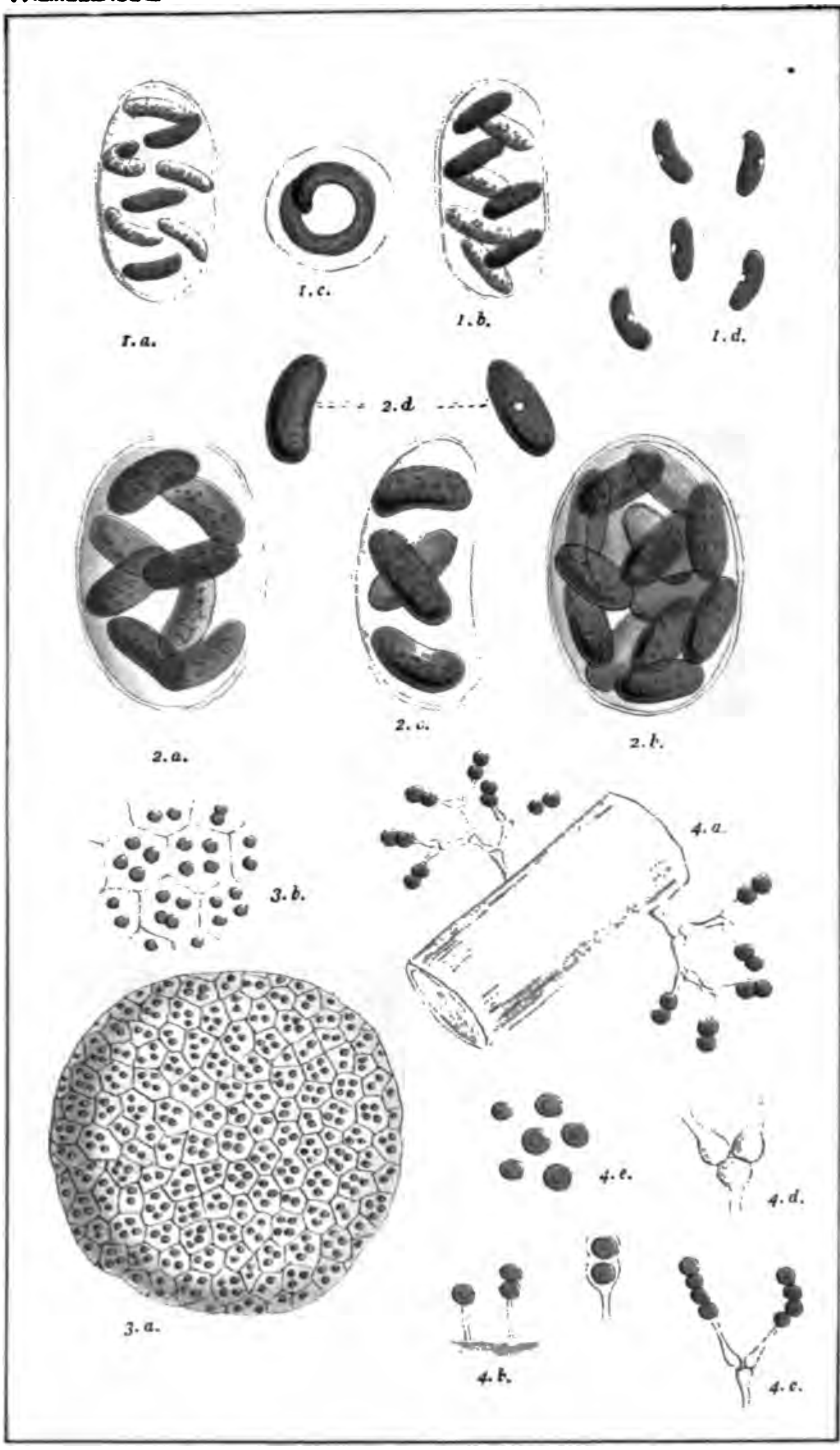
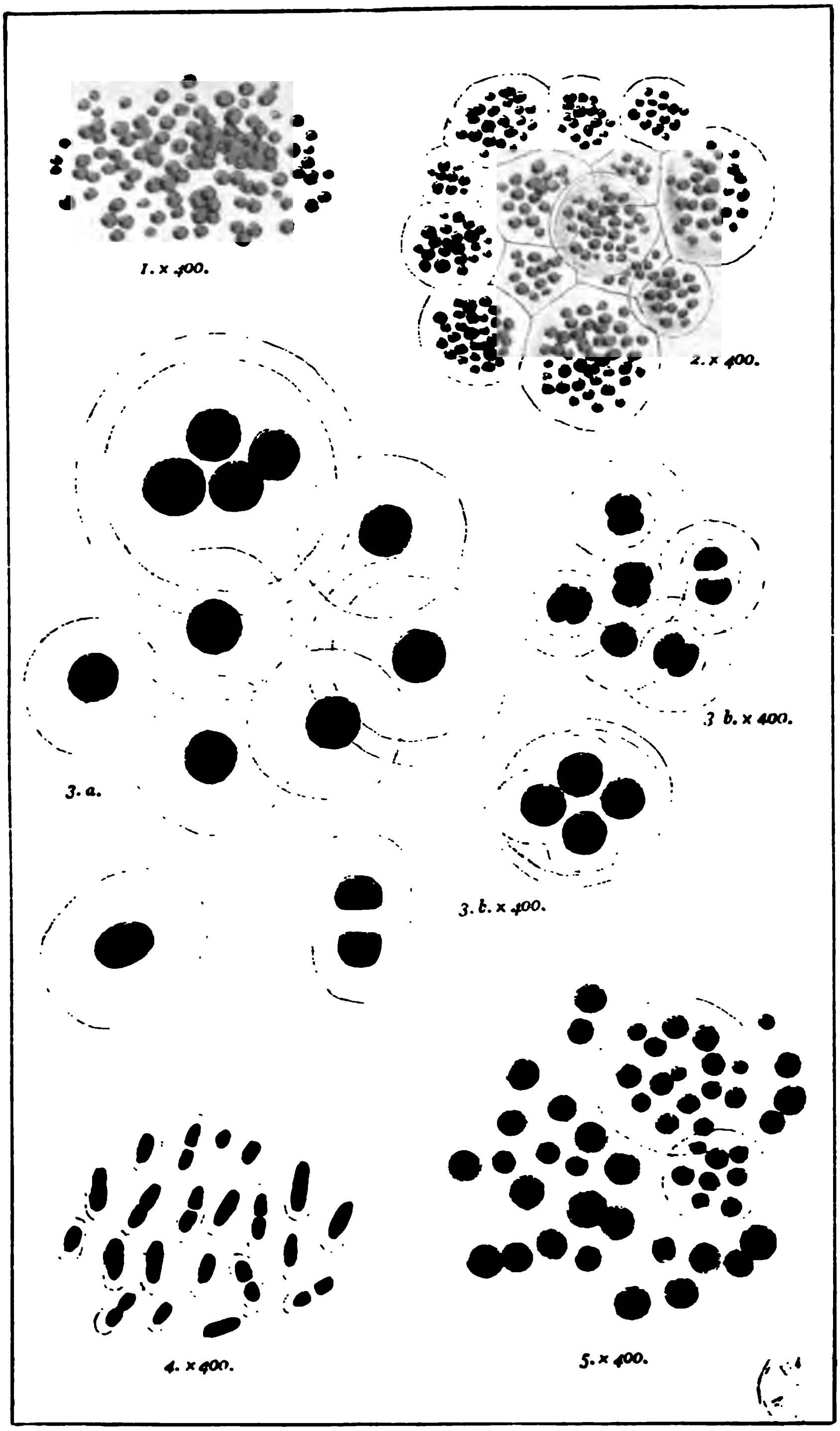
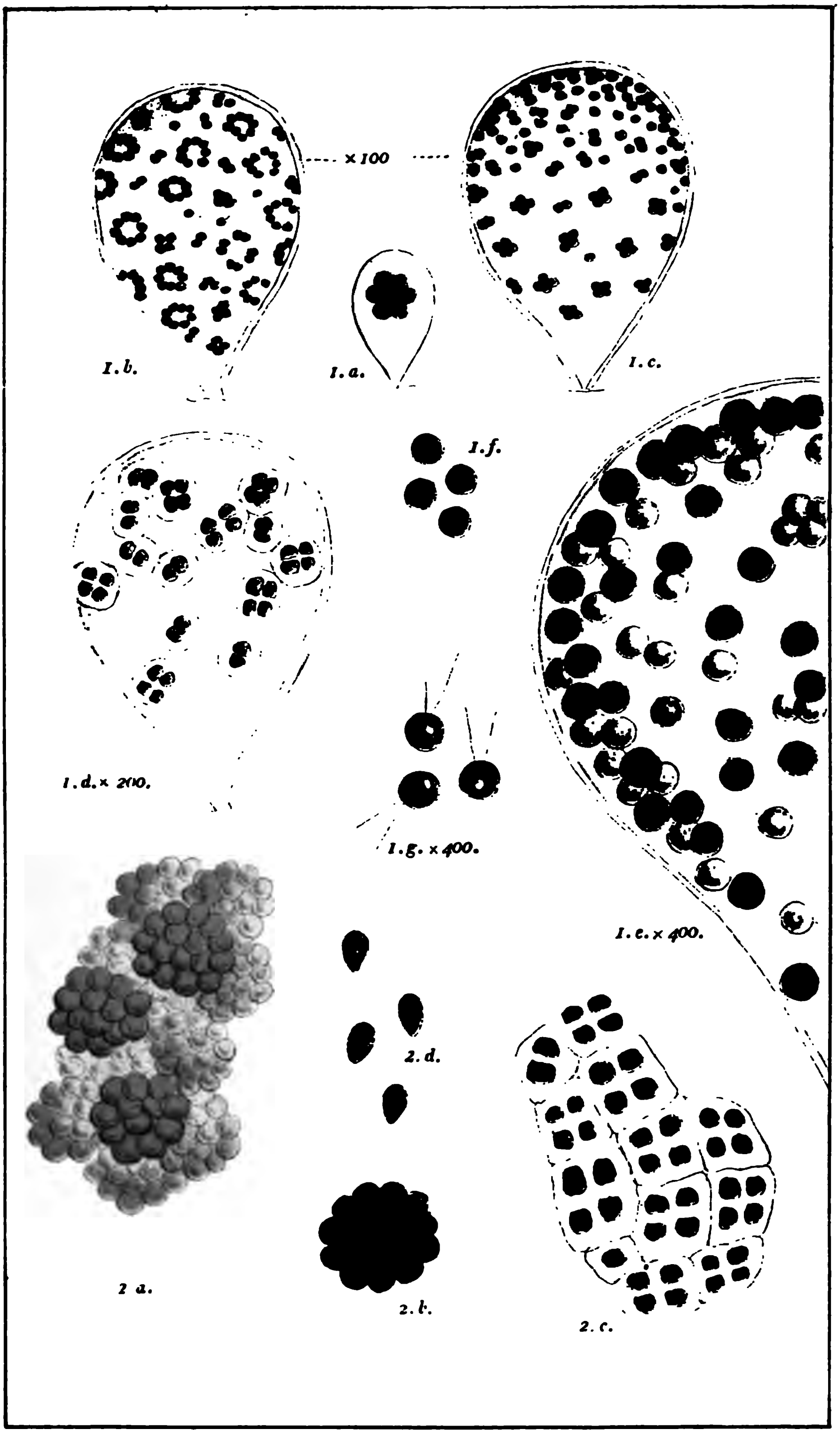


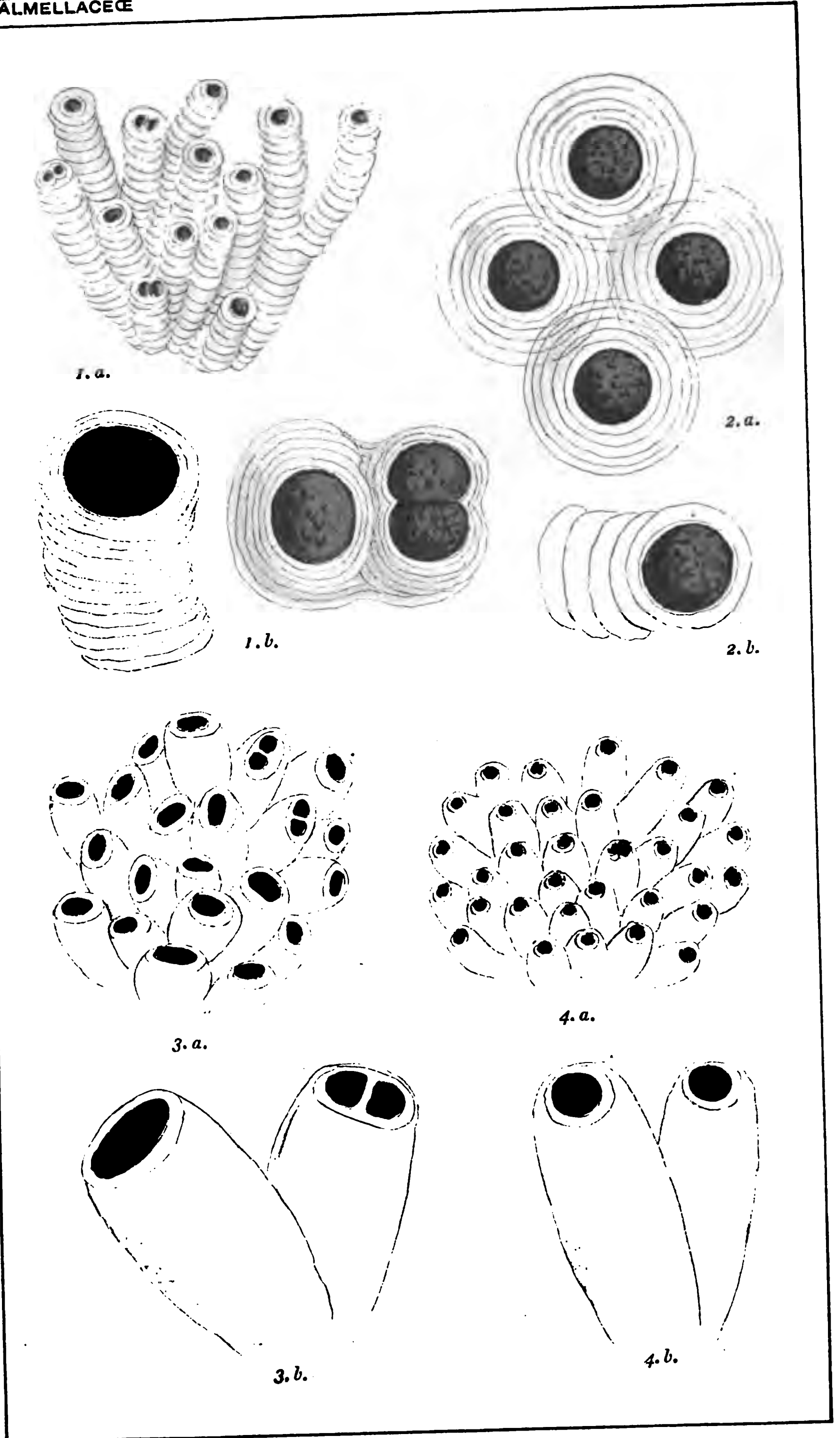
1. *Nephrocytium Agardhianum. Nag.* 2. *Nephrocytium Naegelii. Gr.*
3. *Botrydina vulgaris. Breb.* 4. *Mischococcus confervicola. Nag.*



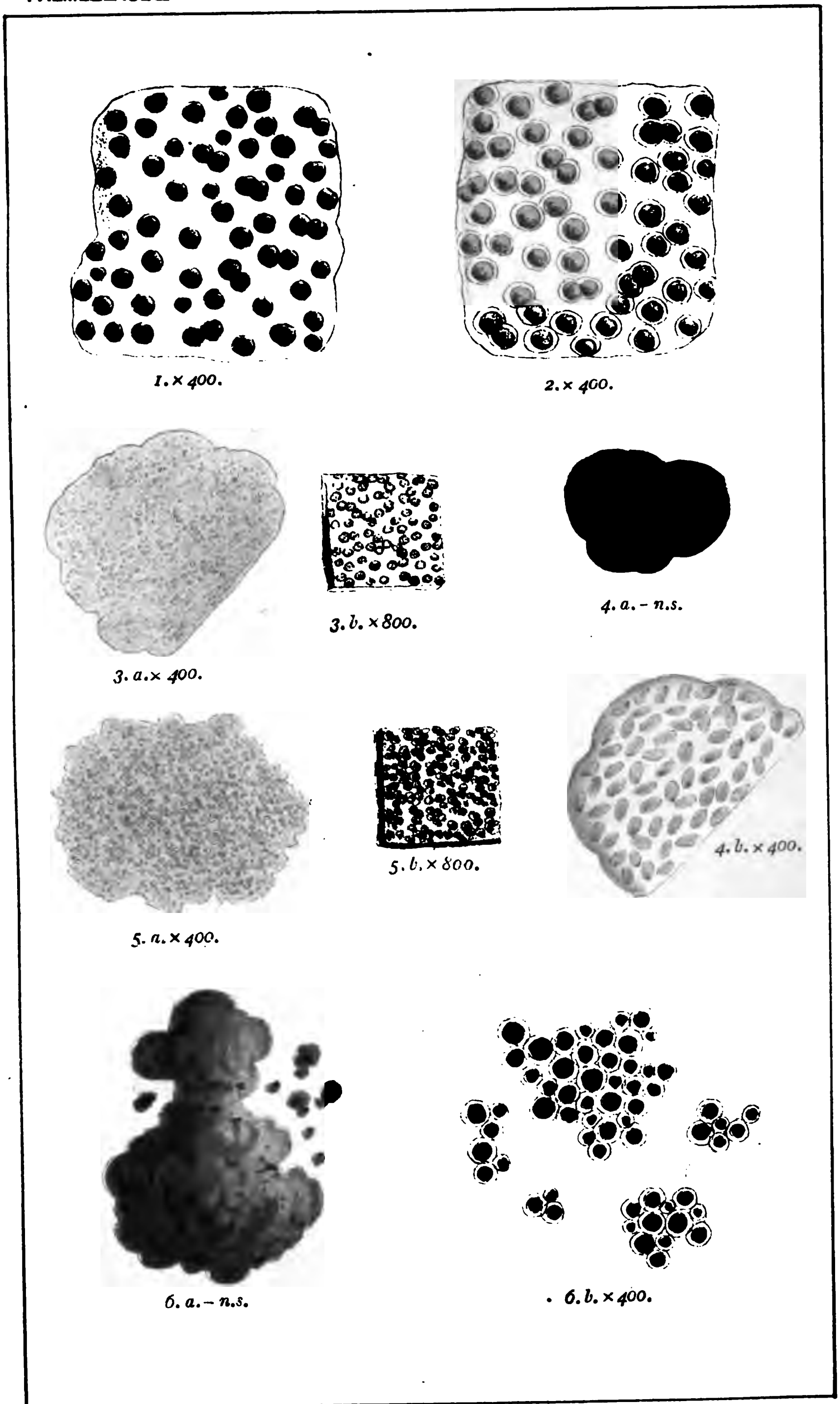
1. *Protococcus viridis. Ag.* 2. *Chlorococcum frustulosum. Carm.*
3. *Chlorococcum gigas. Grun.* 4. *Chlorococcum murorum. Grev.*
5. *Chlorococcum humicola. Näg.*



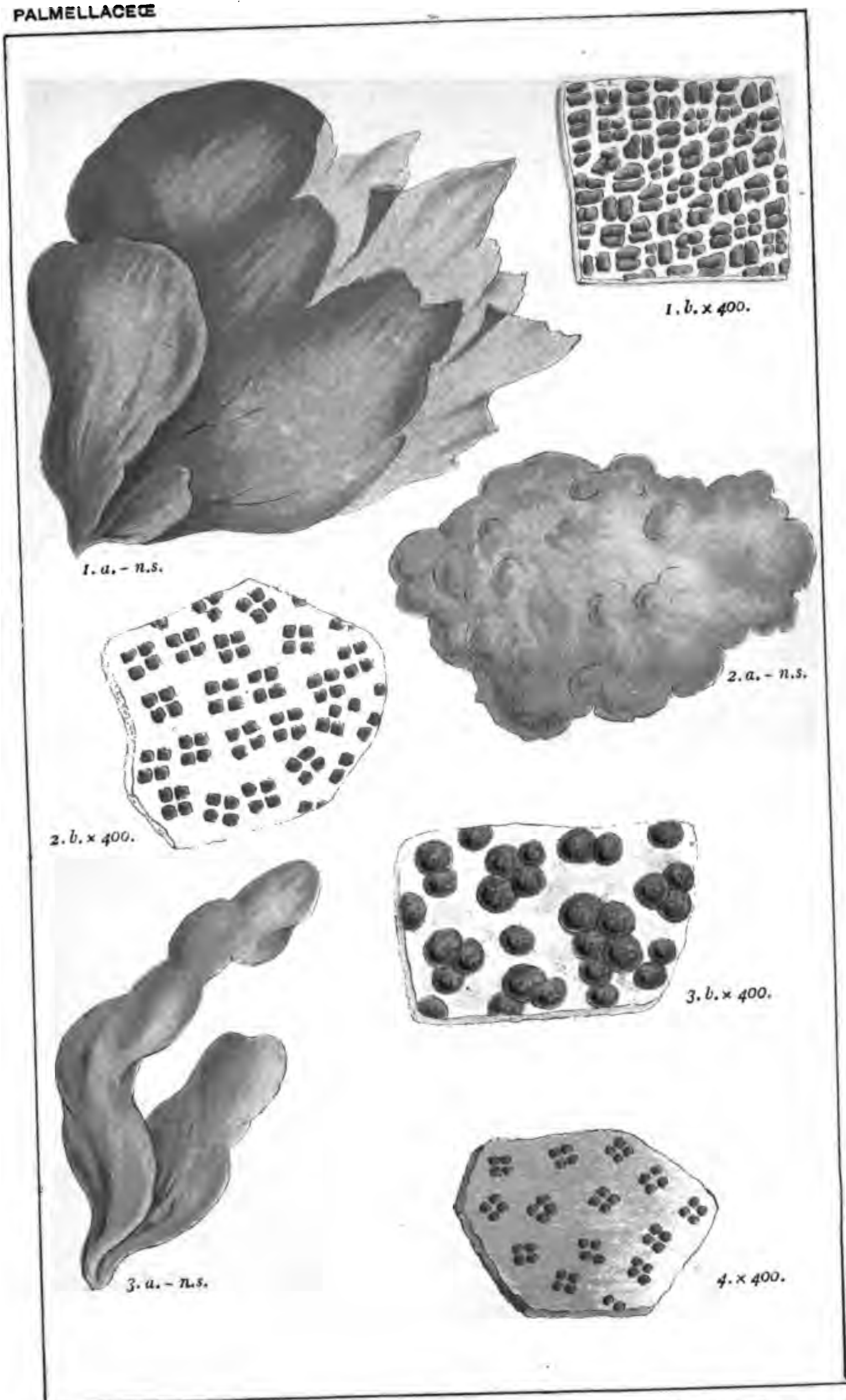
1. *Apiocystis Brauniana. Nag.* 2. *Botryococcus Braunii. Kutz.*



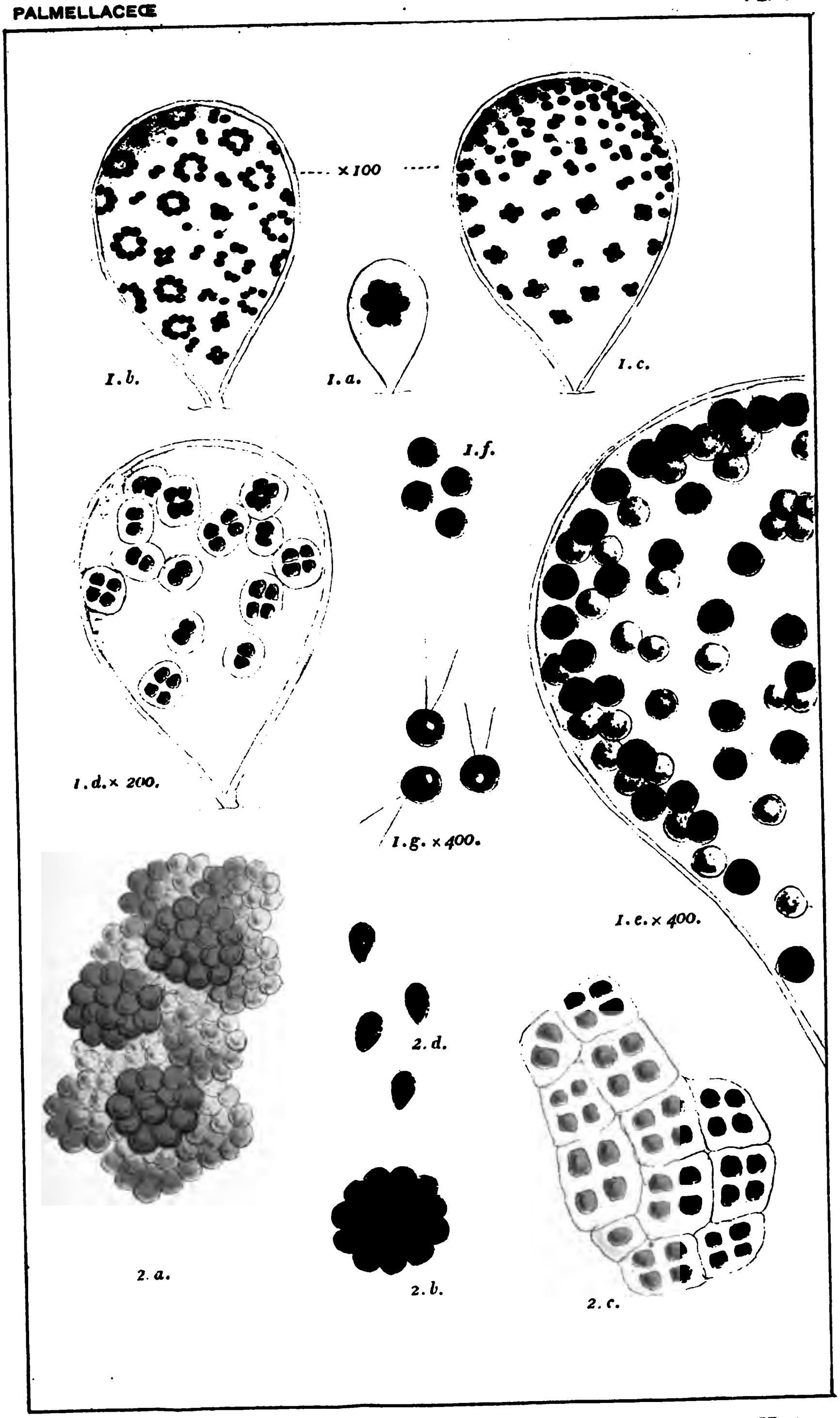
1. *Urococcus Hookerianus, Hass.* 2. Urococcus insignis Hass.
3. *Urococcus Allmanni. Hass.* 4. Urococcus cryptophilus. H



1. Palmella mucosa. Kutz.
2. Palmella miniata. v. æqualis. Na
3. Palmella hyalina. Breb.
4. Palmella Mooreana. Harv.
5. Palmella prodigiosa. Elor.
6. Porphyridium cruentum. Ag.



1. *Tetraspora bullosa Ag.* 2. Tetraspora gelatinosa Desv.
3. *Tetraspora lubrica. Ag.* 4. Tetraspora flava Hass.



1. *Apiocystis Brauniana. Nag.* 2. Botryococcus Braunii. Kutz.

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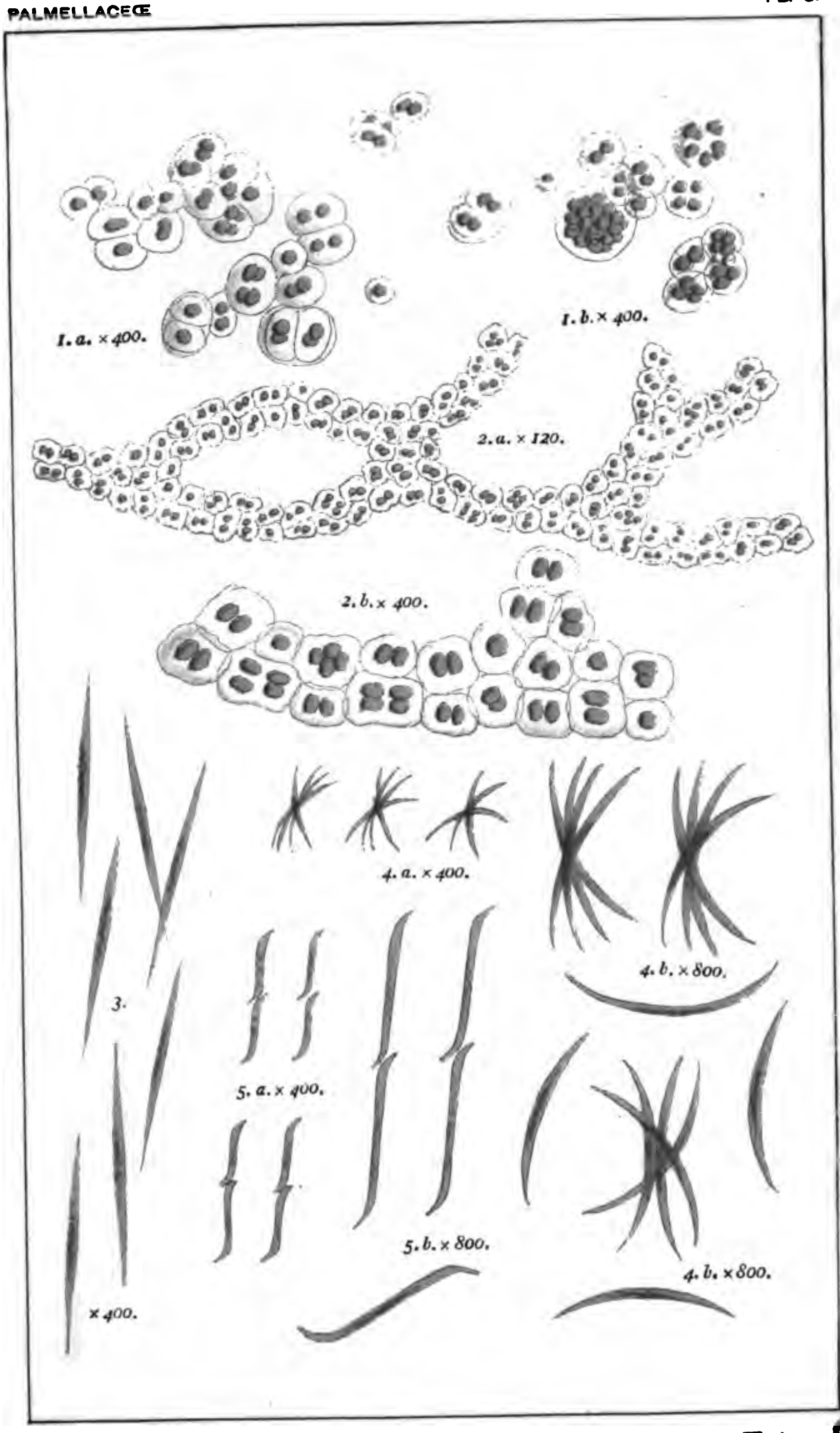
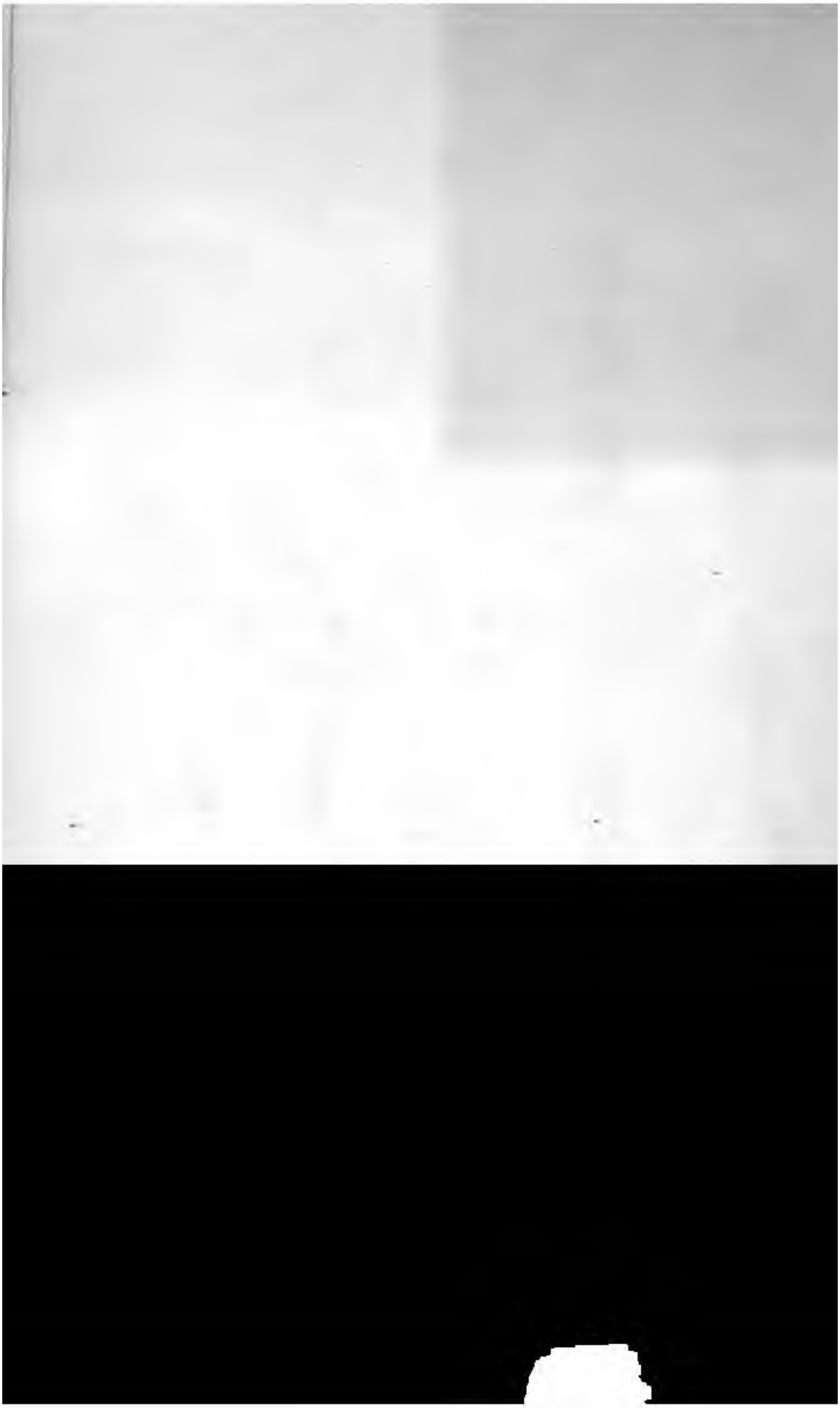
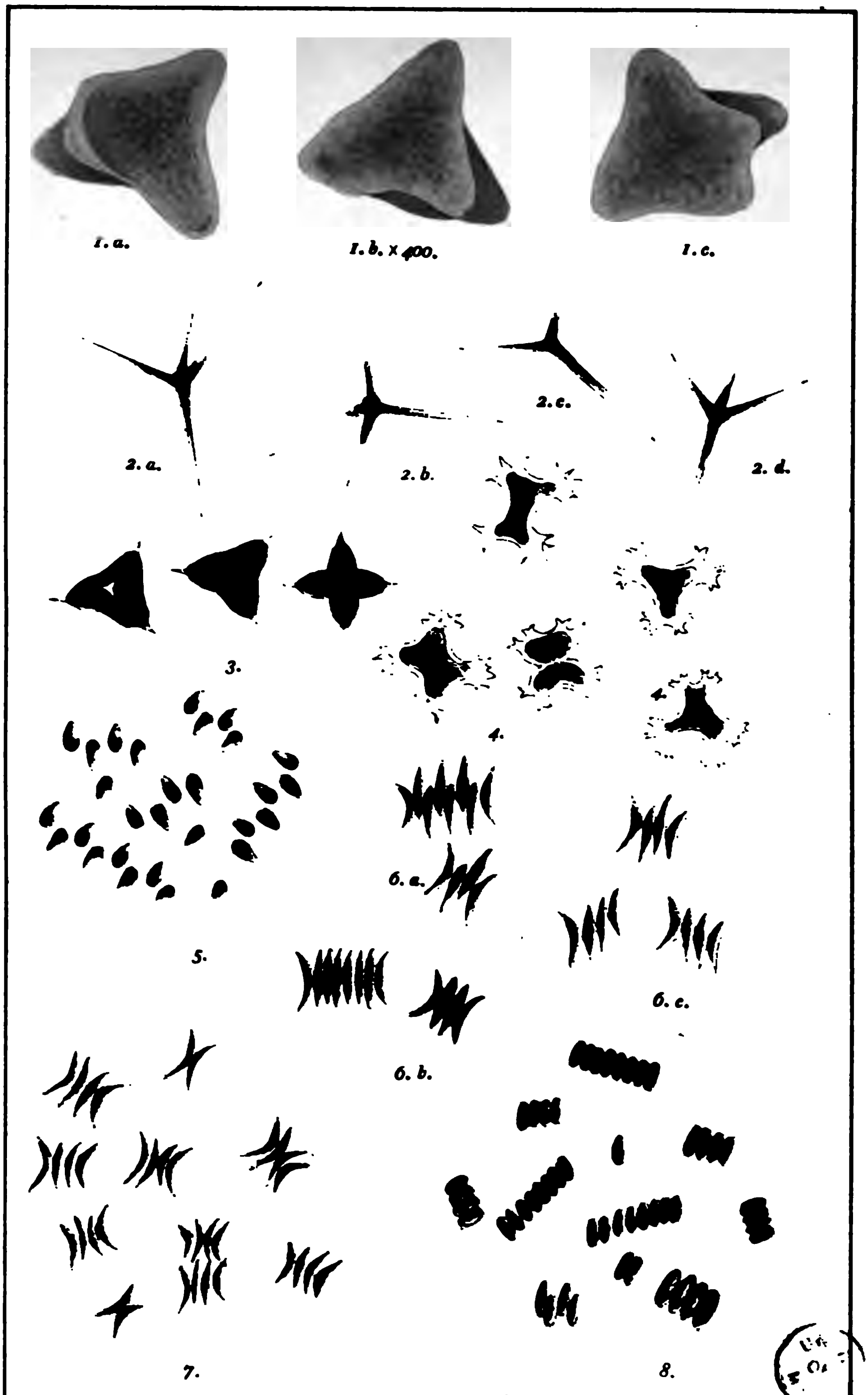
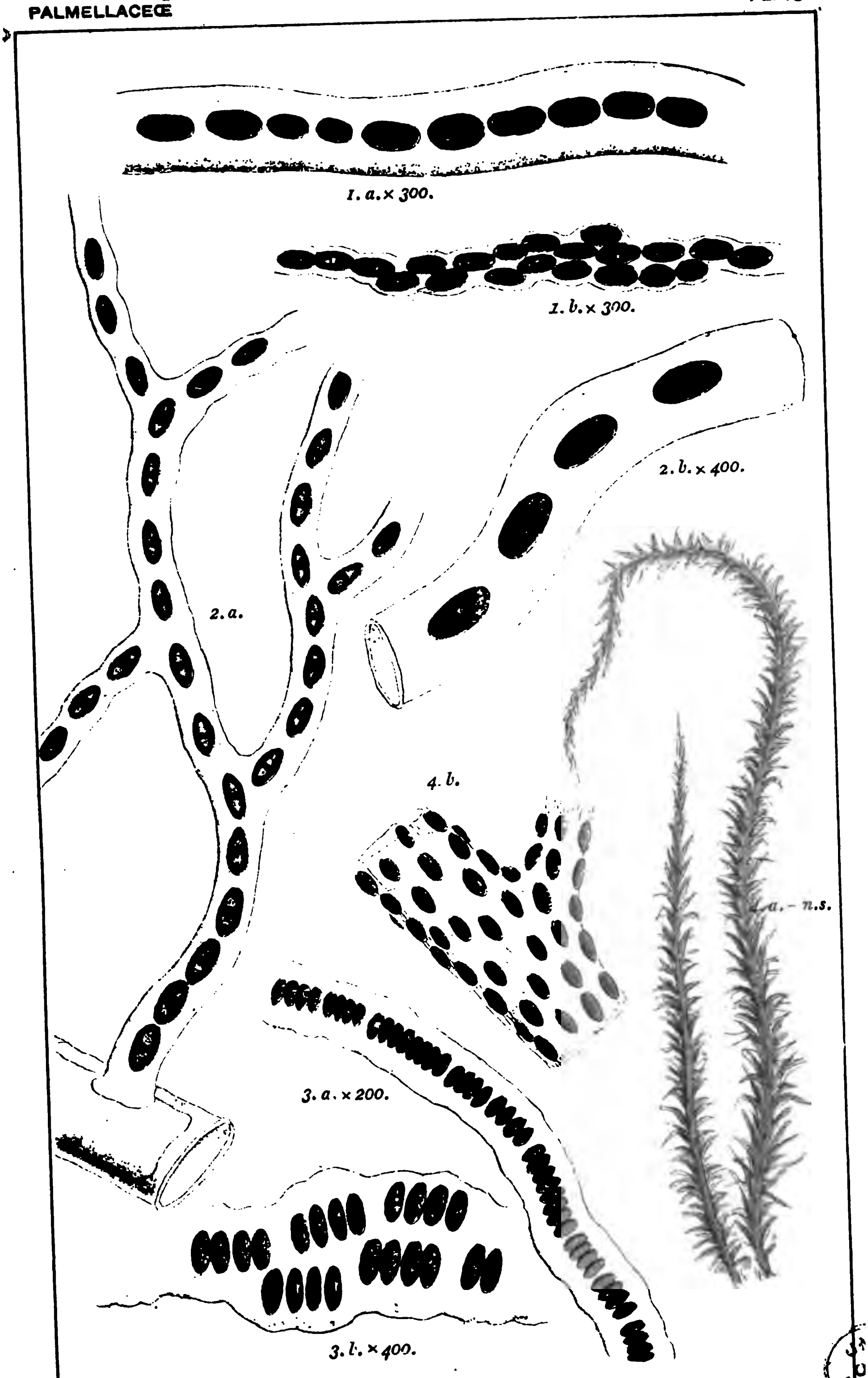


1. *Glæocystis rupestris. Lyng.* 2. Palmodictyon viride. Kutz.
3. *Rhaphidium aciculare Br.* 4. Rhaphidium falcatum. Rabh.
5. Rhaphidium duplex. Kutz.

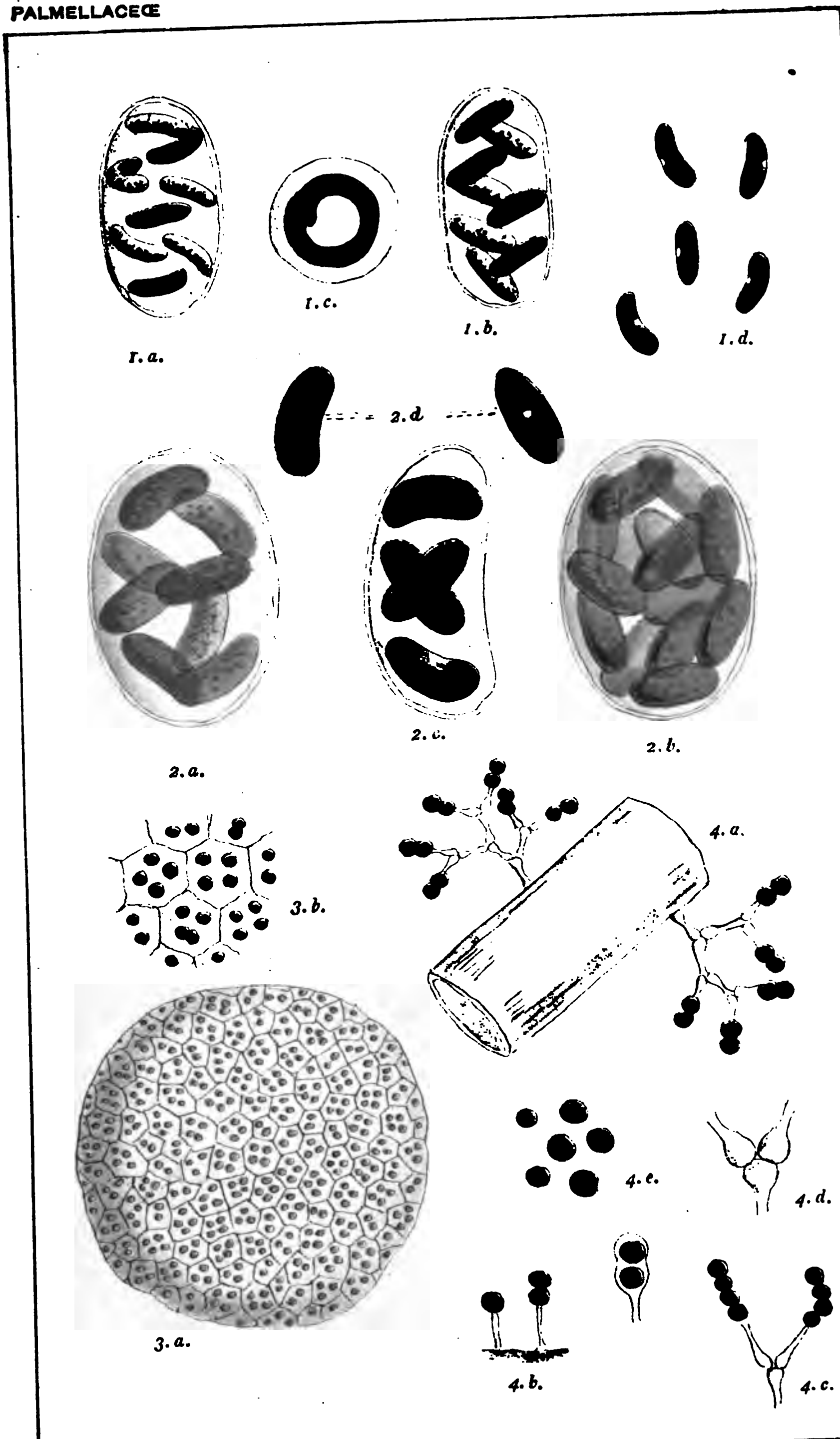




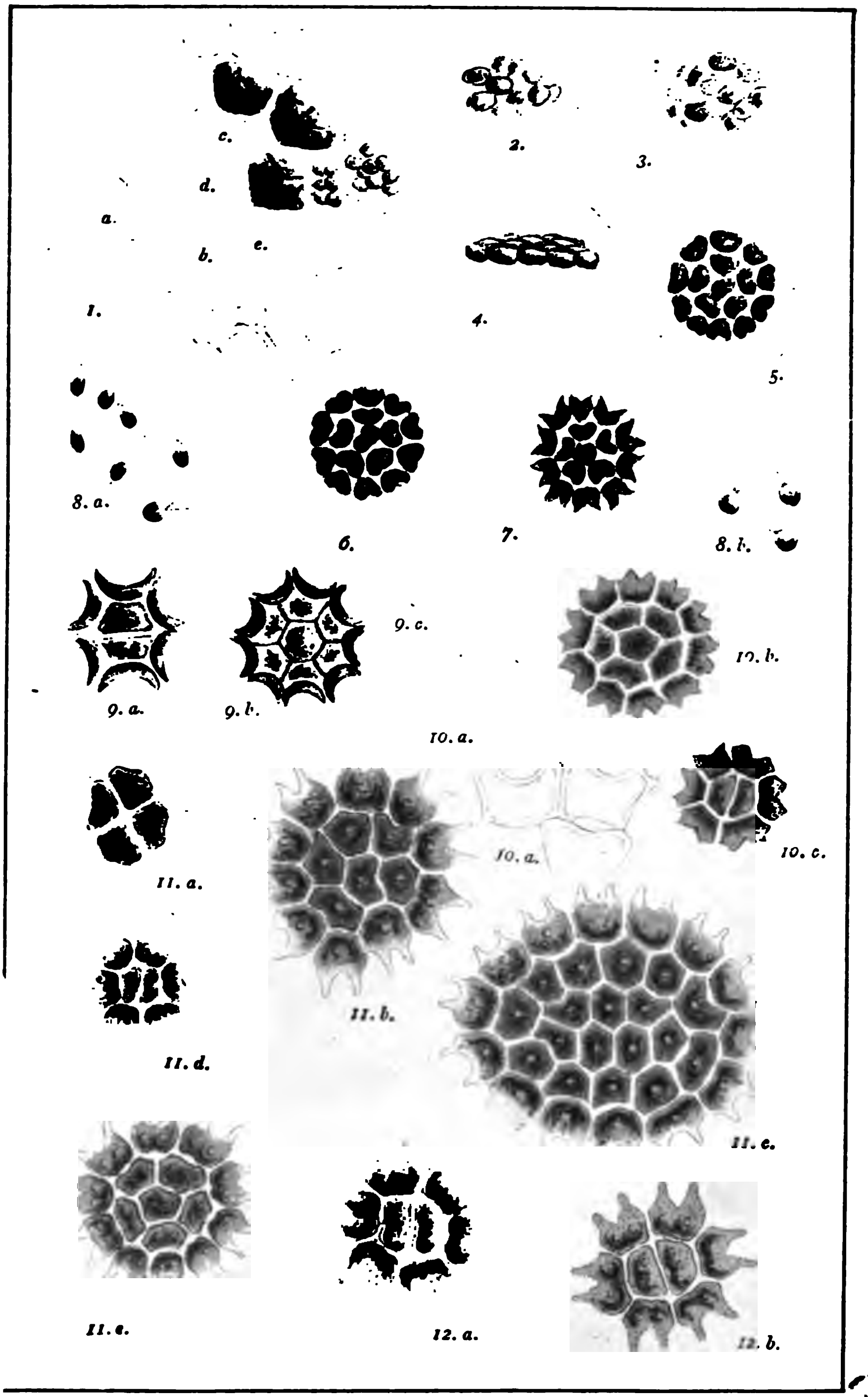
1. *Polyedrium gigas. Wittr.*
2. *Polyedrium longispinum. Perty.*
3. *Polyedrium tetrahedrioum. Nag.*
4. *Polyedrium enorme. DBary.*
5. *Scenedesmus obtusus. Mey.*
6. *Scenedesmus acutus. Mey.*
7. *Scenedesmus antennatus. Breb.*
8. Scenedesmus quadricauda.



1. Hormospora mutabilis. Breb.
2. Hormospora ramosa. Thw.
3. Hormospora transversalis. Breb.
4. Hydrurus penicillatus. Ag.



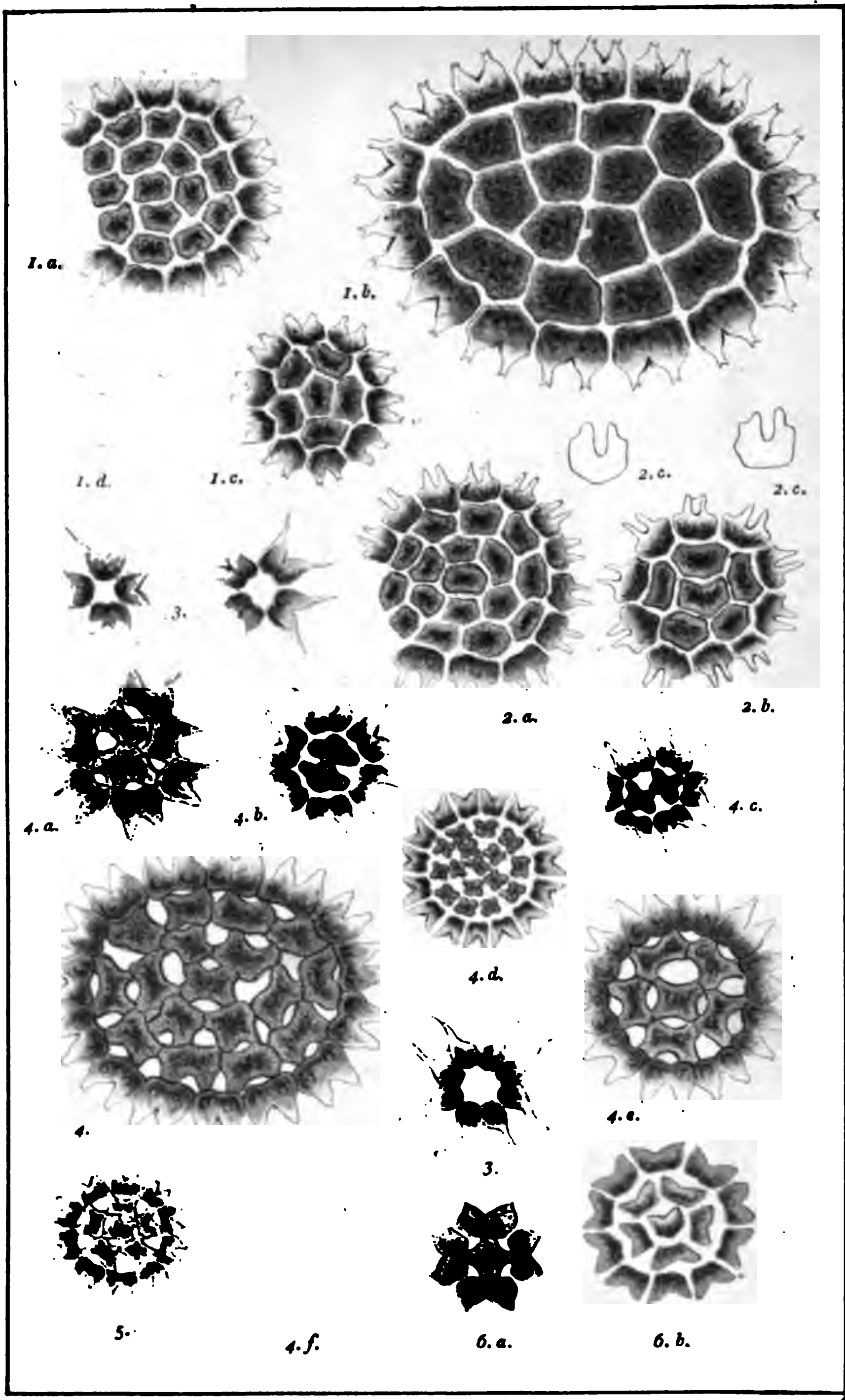
1. *Nephrocytium Agardhianum. Nag.* 2. Nephrocytium Naegelii. Gr.
3. *Botrydina vulgaris. Breb.* 4. Mischococcus confervicola. N



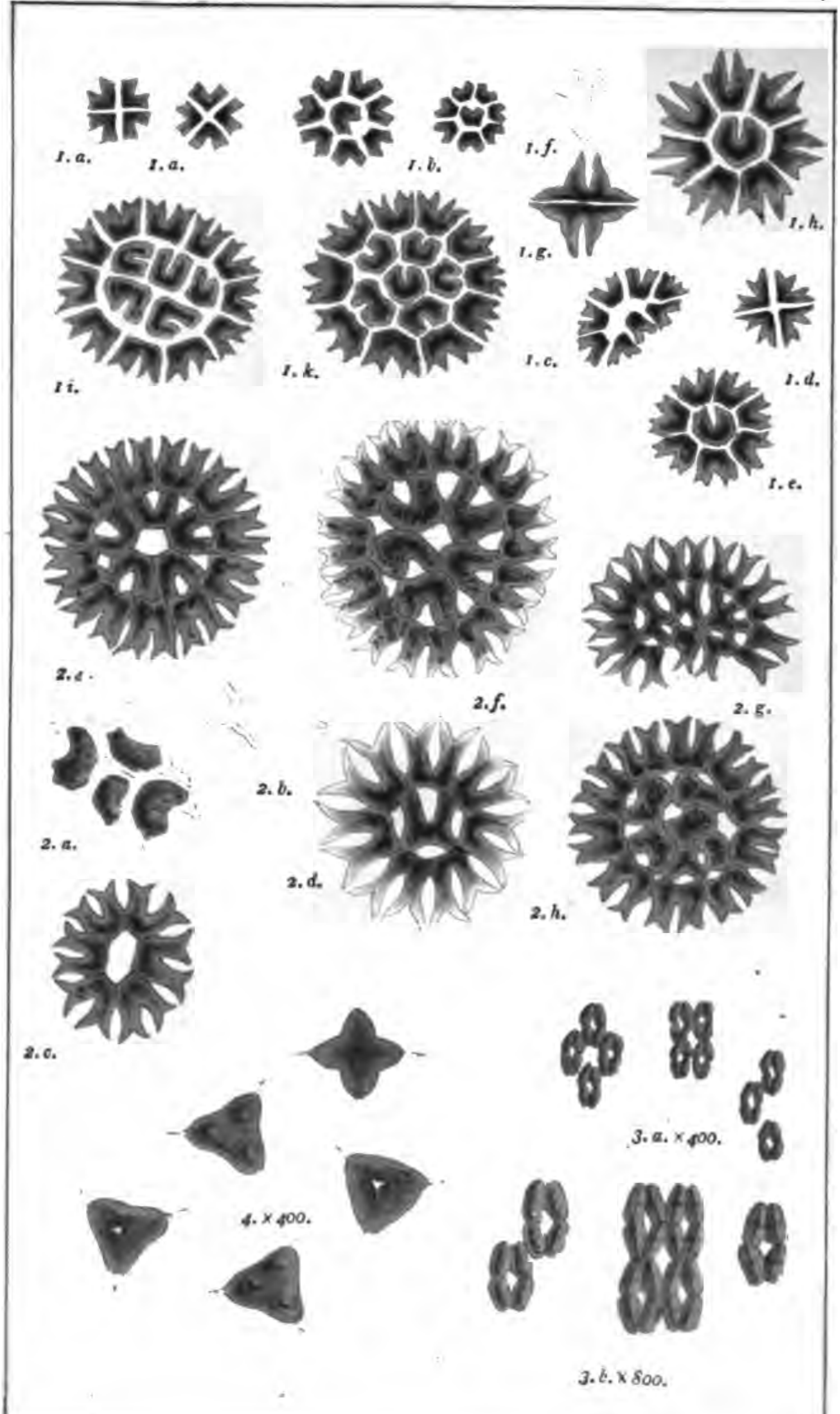
1-7. *Stages of development in Pediastrum Boryanum. Turp.*

9. *Pediastrum Selenaea. Kutz.* 10. *Pediastrum angulosum. Ehrb.*

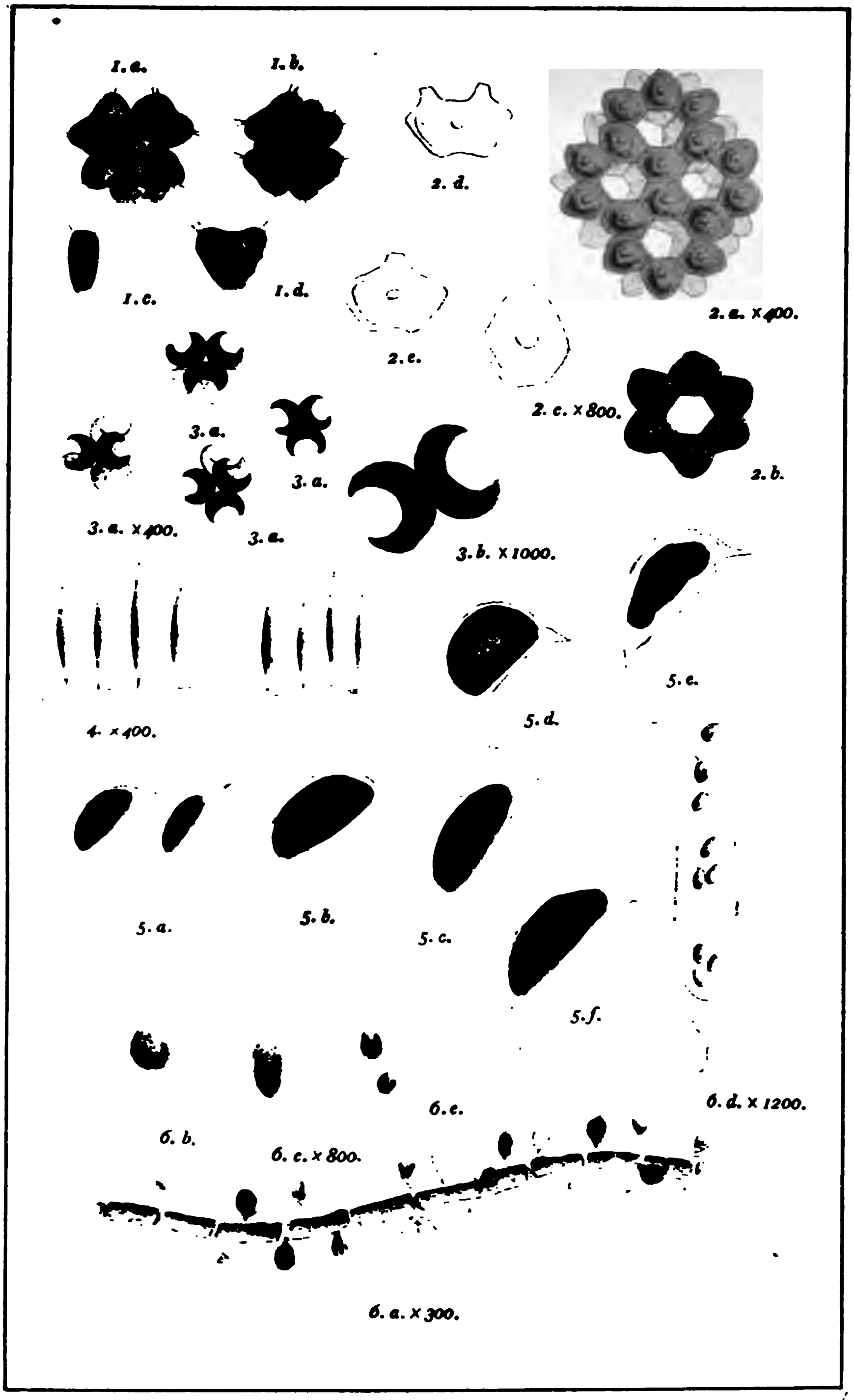
11. *Pediastrum Boryanum. Turp.* 12. *var. granulosum. Br.*



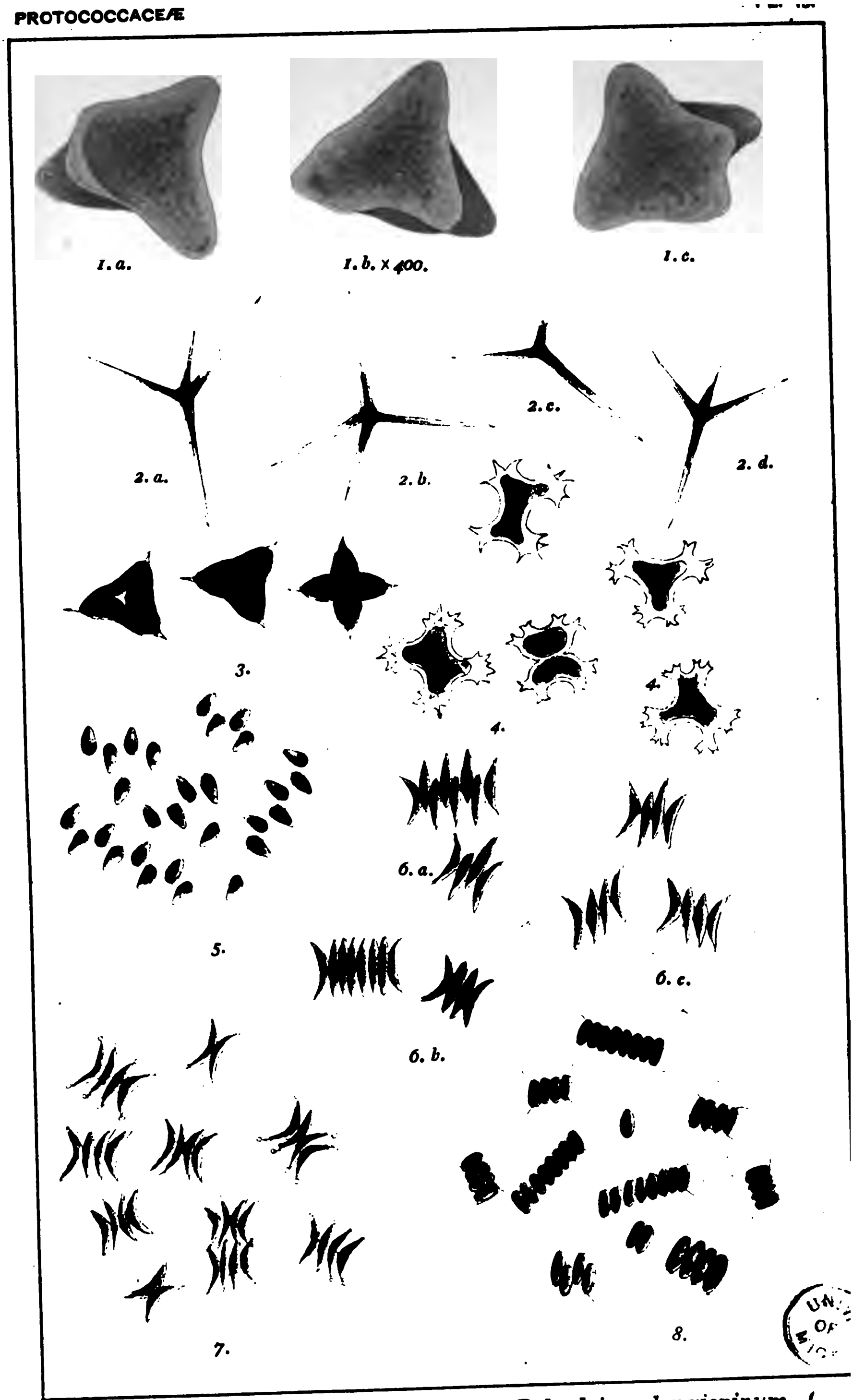
1. Pediastrum bidentulum. Br.
2. Pediastrum constrictum. Hass
3. Pediastrum gracile. Br.
4. Pediastrum pertusum Kutz.
5. P. pertusum v. clathratum Br.
6. P. pertusum v. brachylobum. Br



1. *Pediastrum Ehrenbergii. Corda.* 2. *Pediastrum rotula. Ehrb.*
3. *Staurogenia rectangularis. Nag.* 4. *Polyedrium tetraedricum. Nag.*

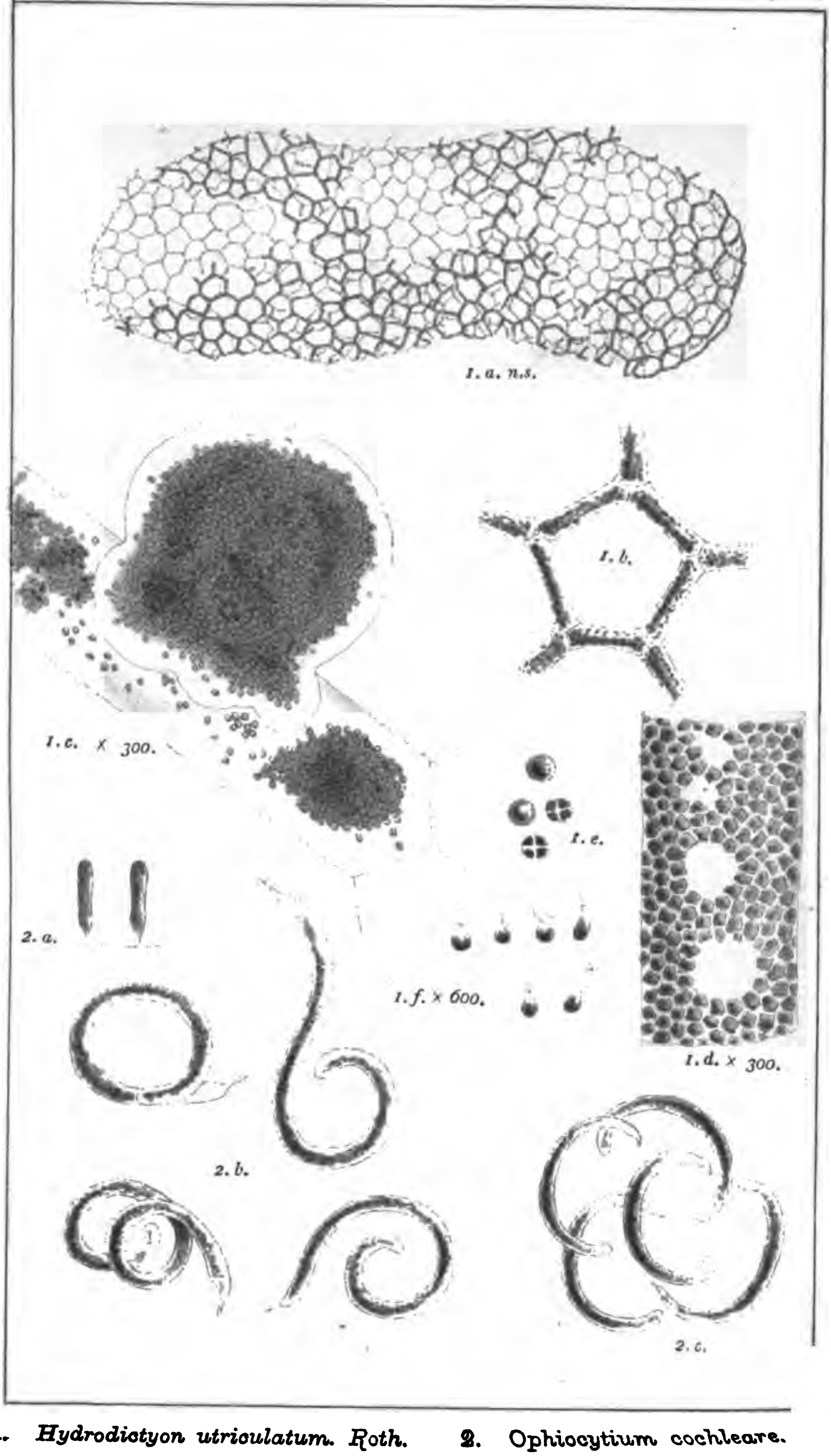


Sorastrum spinulosum. Nag. 2. *Cœlastrum sphæricum. Nag.*
Selenastrum Bibraianum. Reinsch. 4. *Characium tenue. Herm.*
Characium ornithocephalum. Br. 6. *Hydrianum heteromorphum. Reinsc*

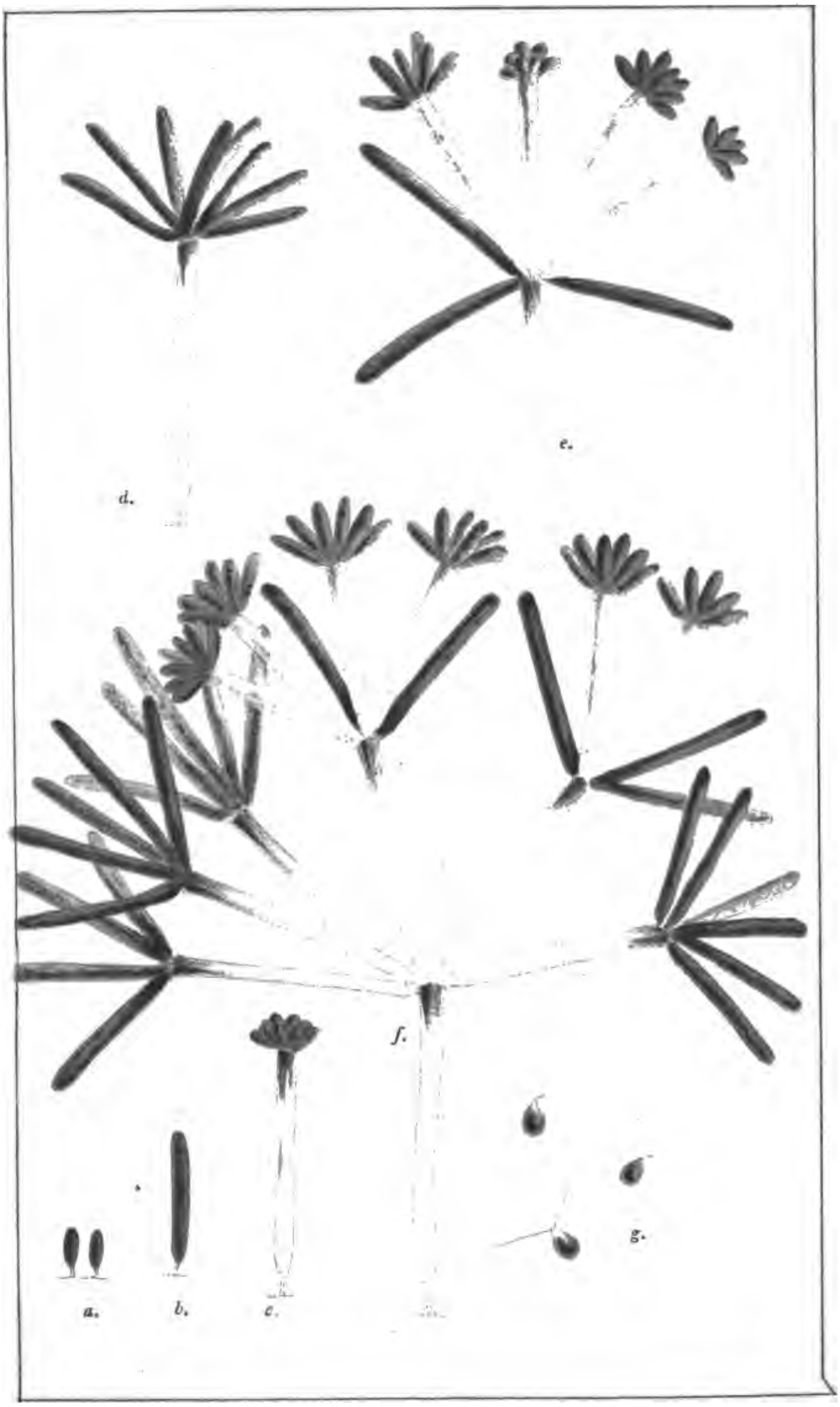


1. *Polyedrium gigas. Wittr.*
2. *Polyedrium longispinum.*
3. *Polyedrium tetrahedricum. Nag.*
4. Polyedrium enorme. DB
5. *Scenedesmus obtusus. Mey.*
6. Scenedesmus acutus. Me
7. [illegible]

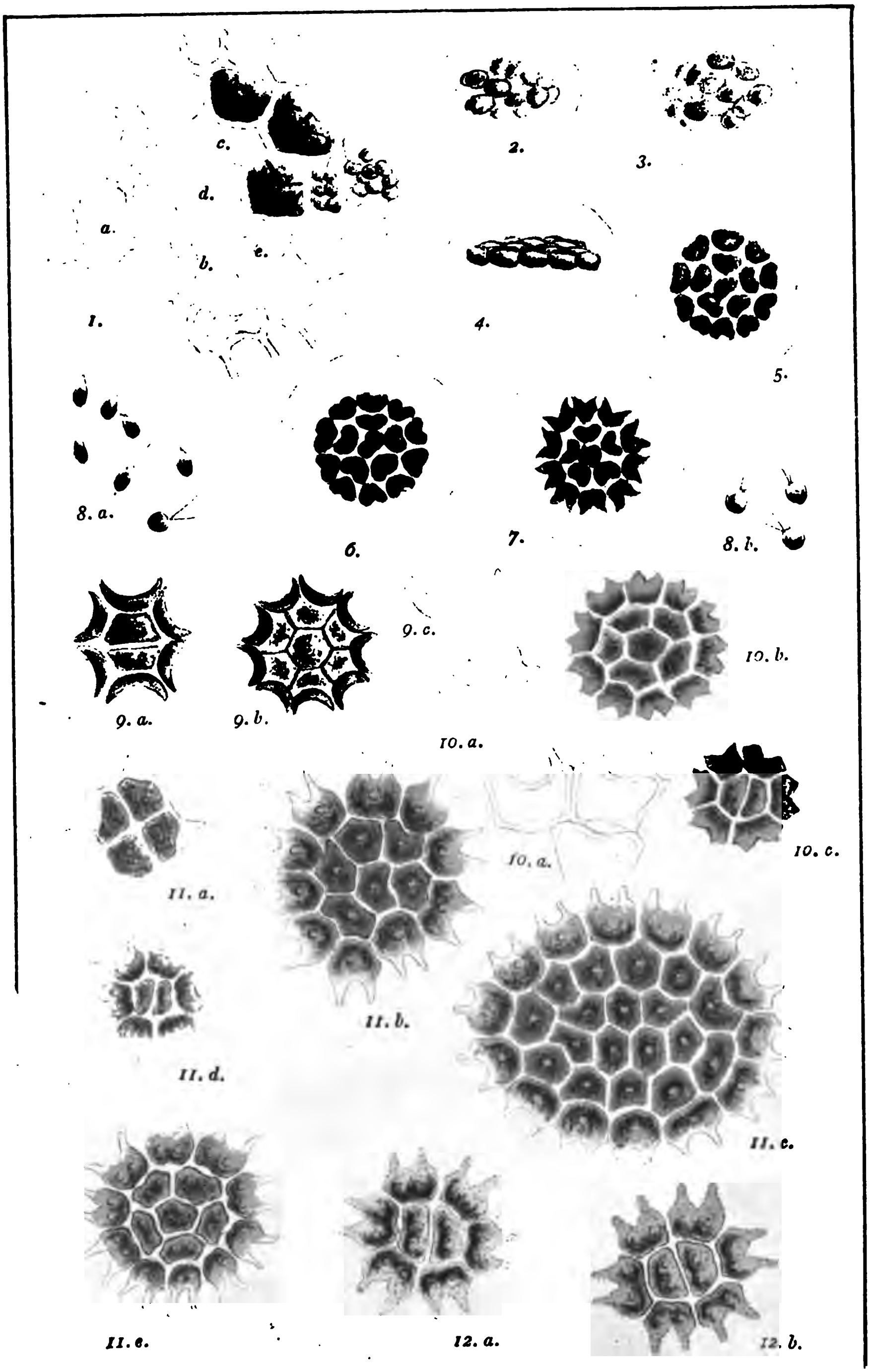
Scenedesmus quadricauda



1. *Hydrodictyon utriculatum*. Roth. 2. Ophiocytium cochleare.



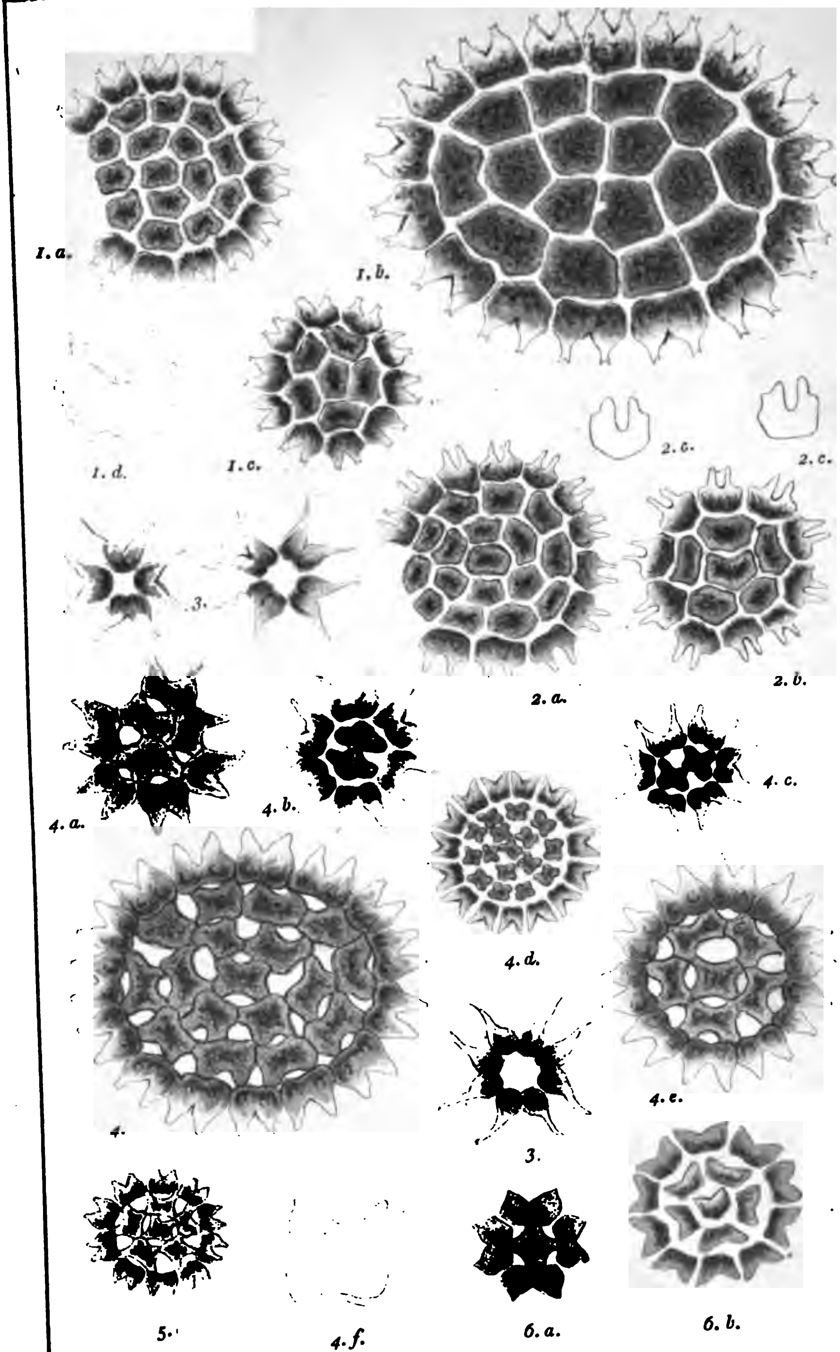
Sciadium arbuscula. Br.



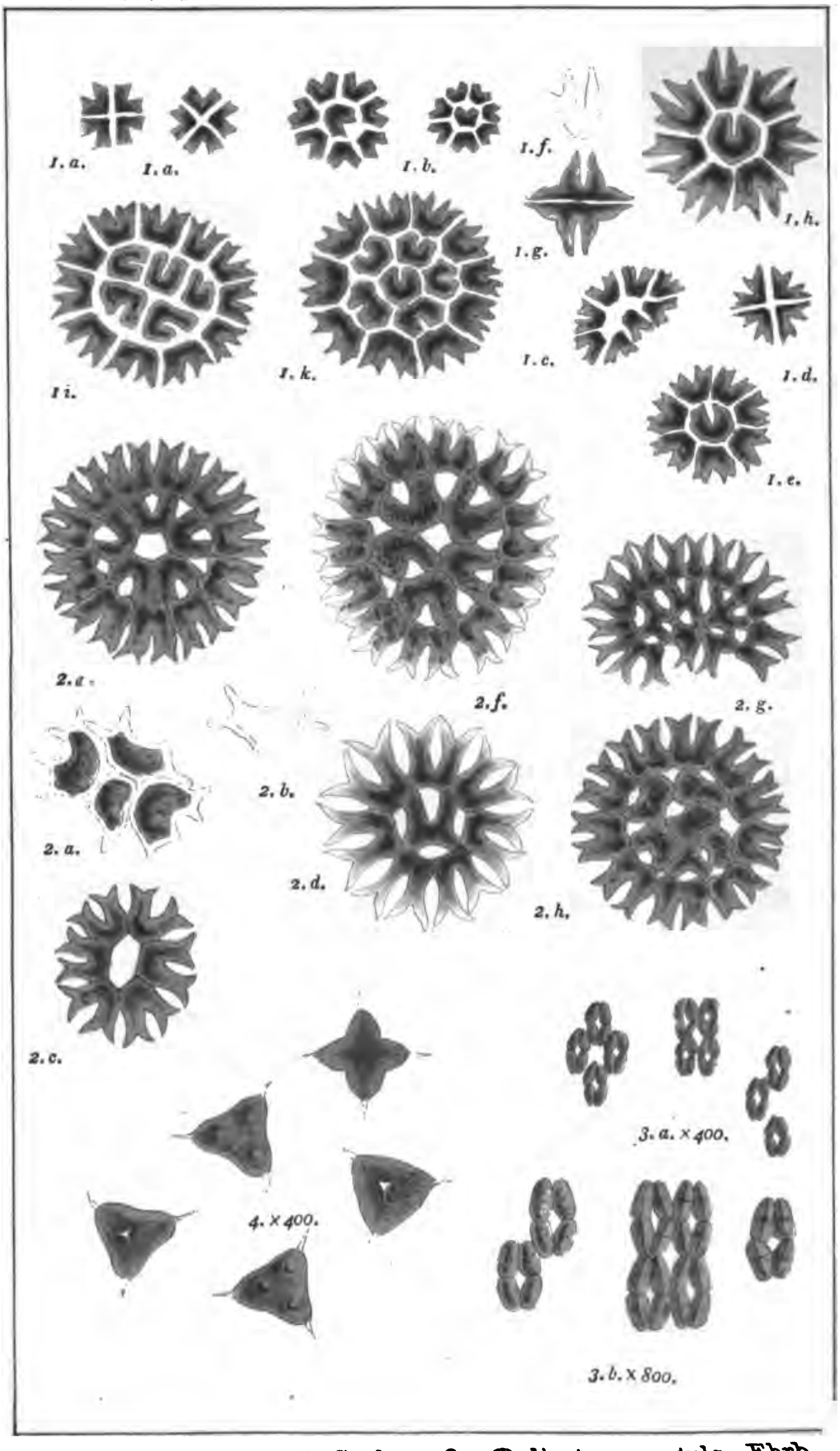
1-7. *Stages of development in Pediastrum Boryanum. Turp.*

9. *Pediastrum Selenaea. Kutz.* 10. Pediastrum angulosum. Ehrb

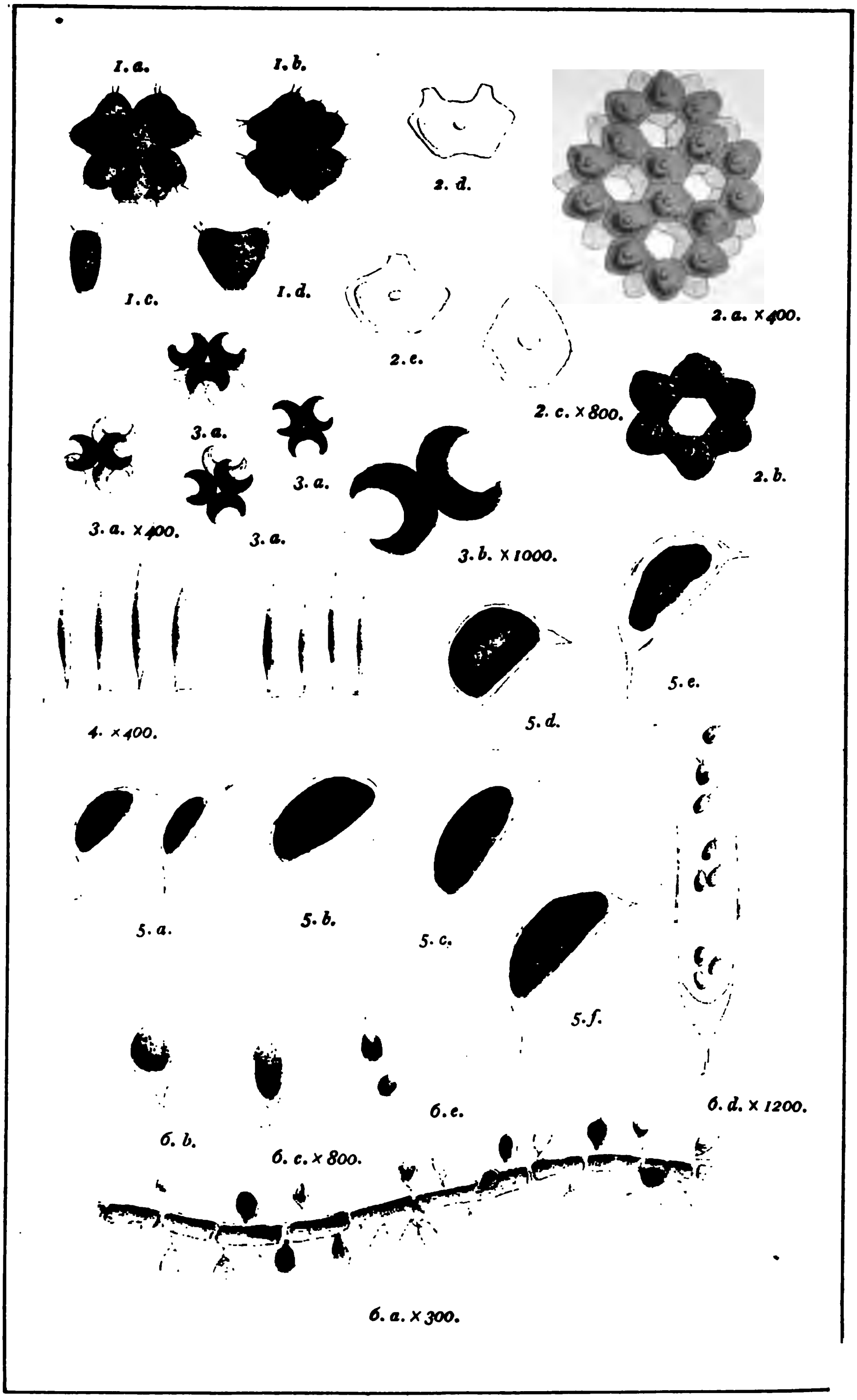
11. *Pediastrum Boryanum. Turp.* 12. var. granulosum. Br.



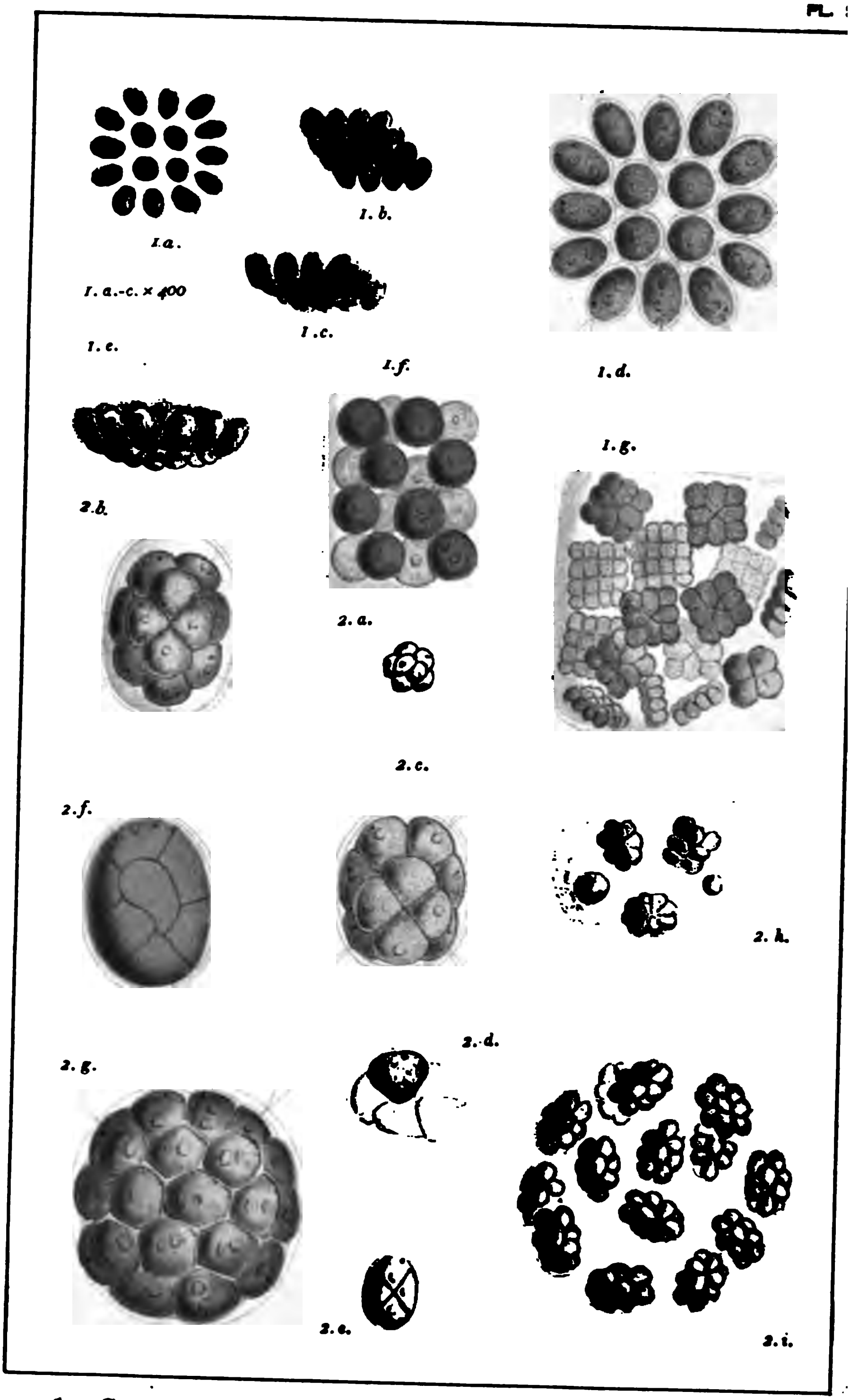
1. *Pediastrum bidentulum. Br.* 2. *Pediastrum constrictum. H*
3. *Pediastrum gracile. Br.* 4. Pediastrum pertusum Ku
5. *P. pertusum v. clathratum Br.* 6. P. pertusum v. brachyl



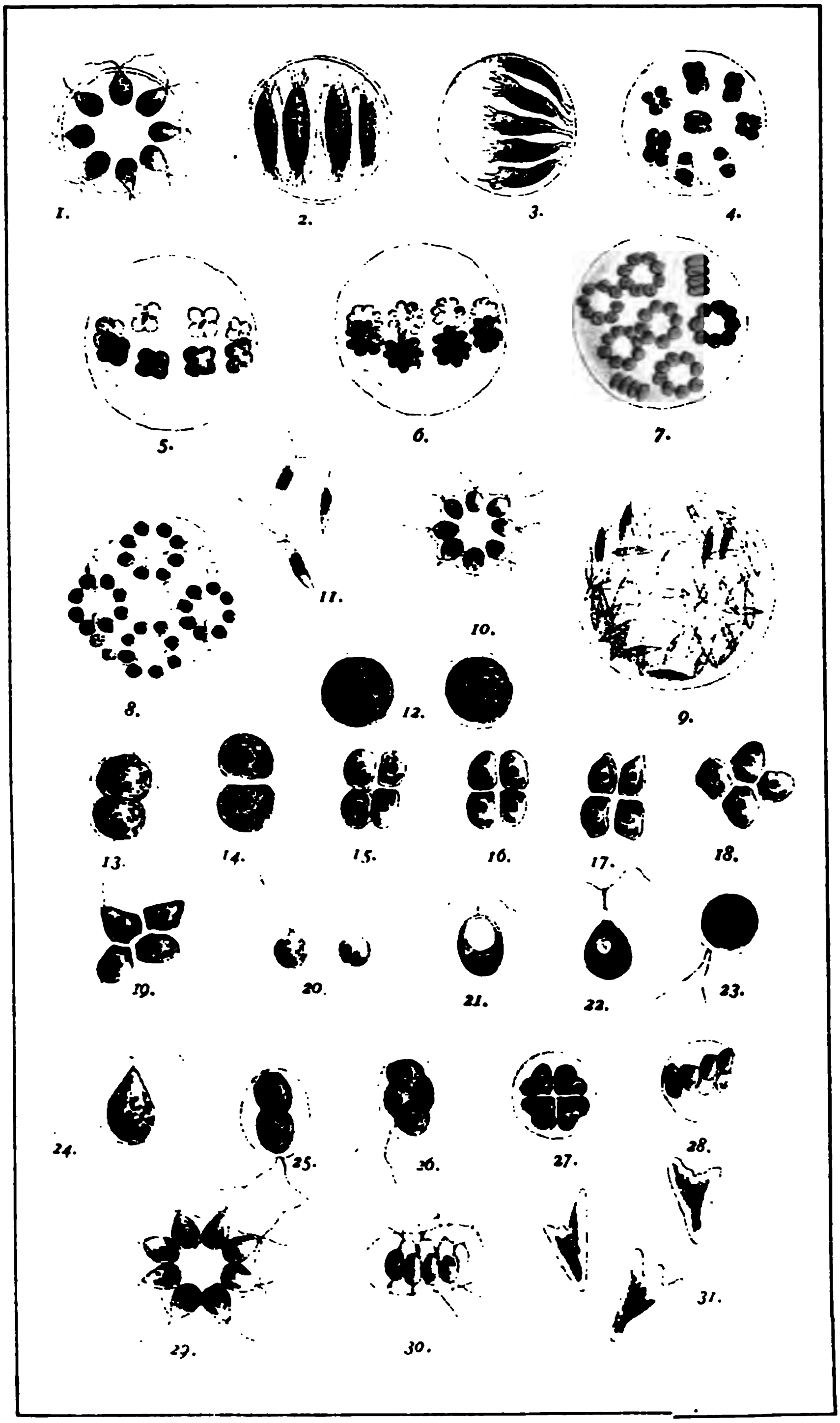
1. *Pediastrum Ehrenbergii. Corda.* 2. Pediastrum rotula. Ehrb.
3. *Staurogenia rectangularis. Nag.* 4. Polyedrium tetraedricum.



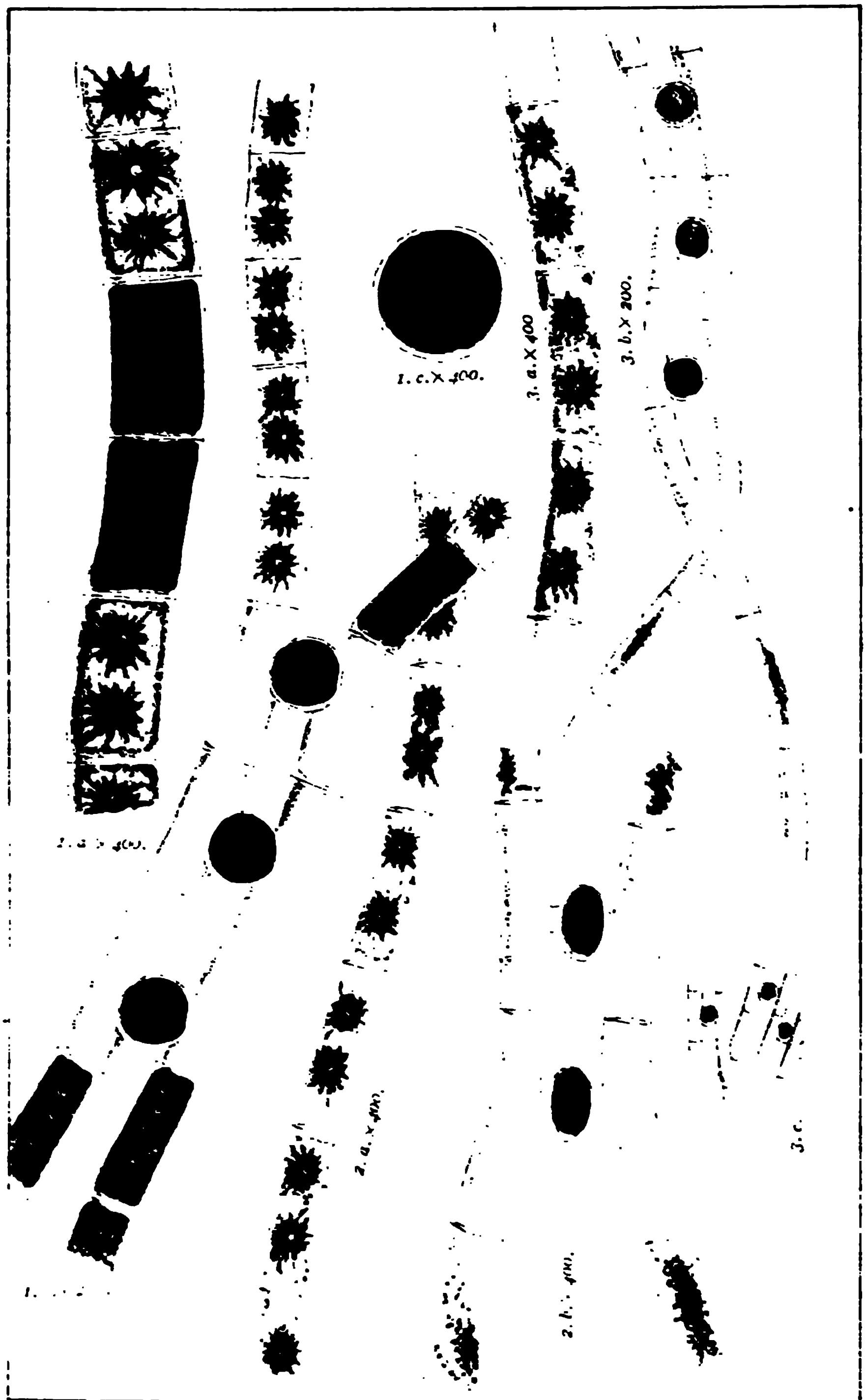
. Sorastrum spinulosum. Nag. 2. Cœlastrum sphæricum. Nag.
. Selenastrum Bibraianum. Reinsch. 4. Characium tenue. Herm.
. Characium ornithocephalum. Br. 6. Hydrianum heteromorphum. Rei.



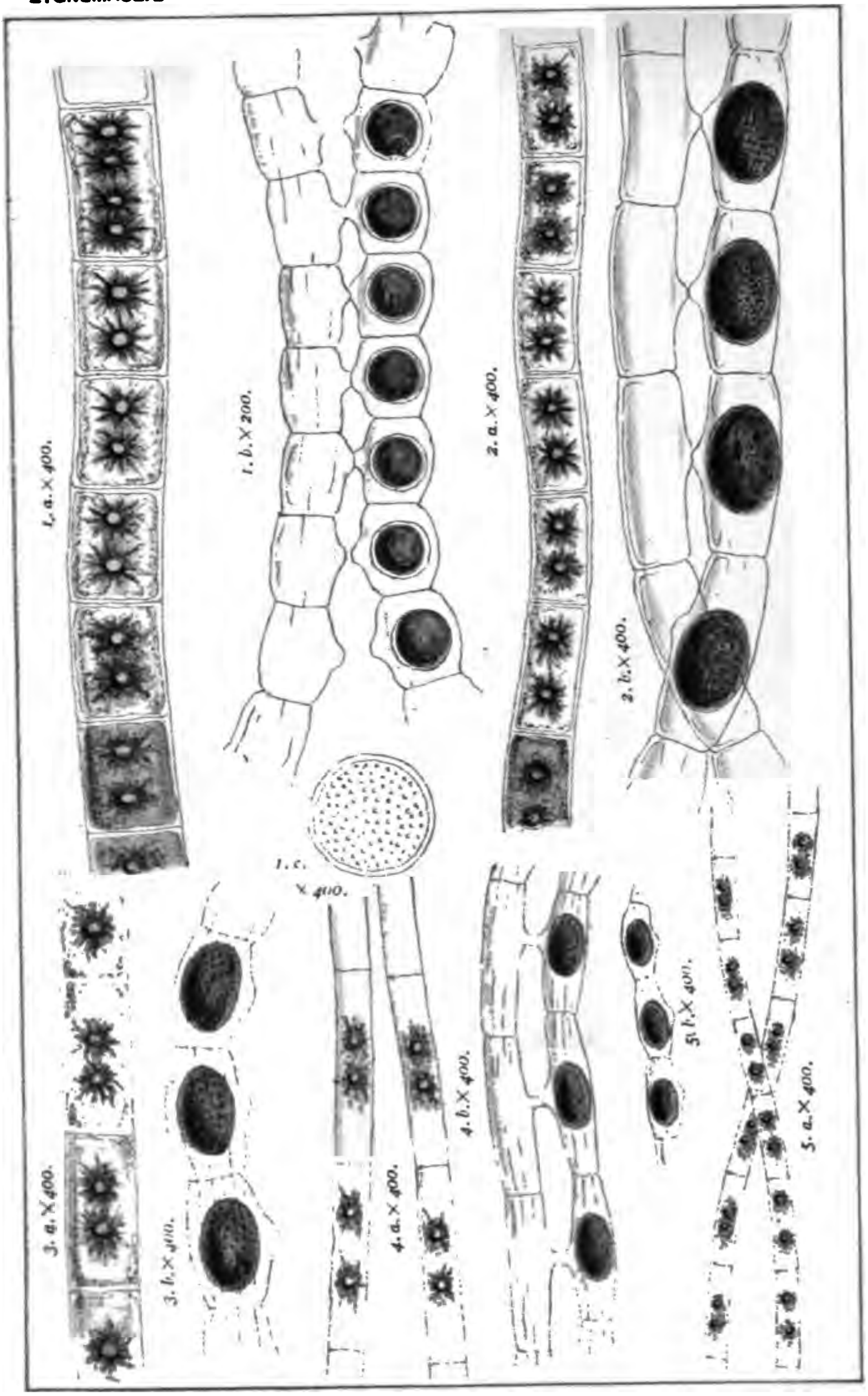
1. Gonium pectorale. Mull. 2. Pandorina morum. Bory.



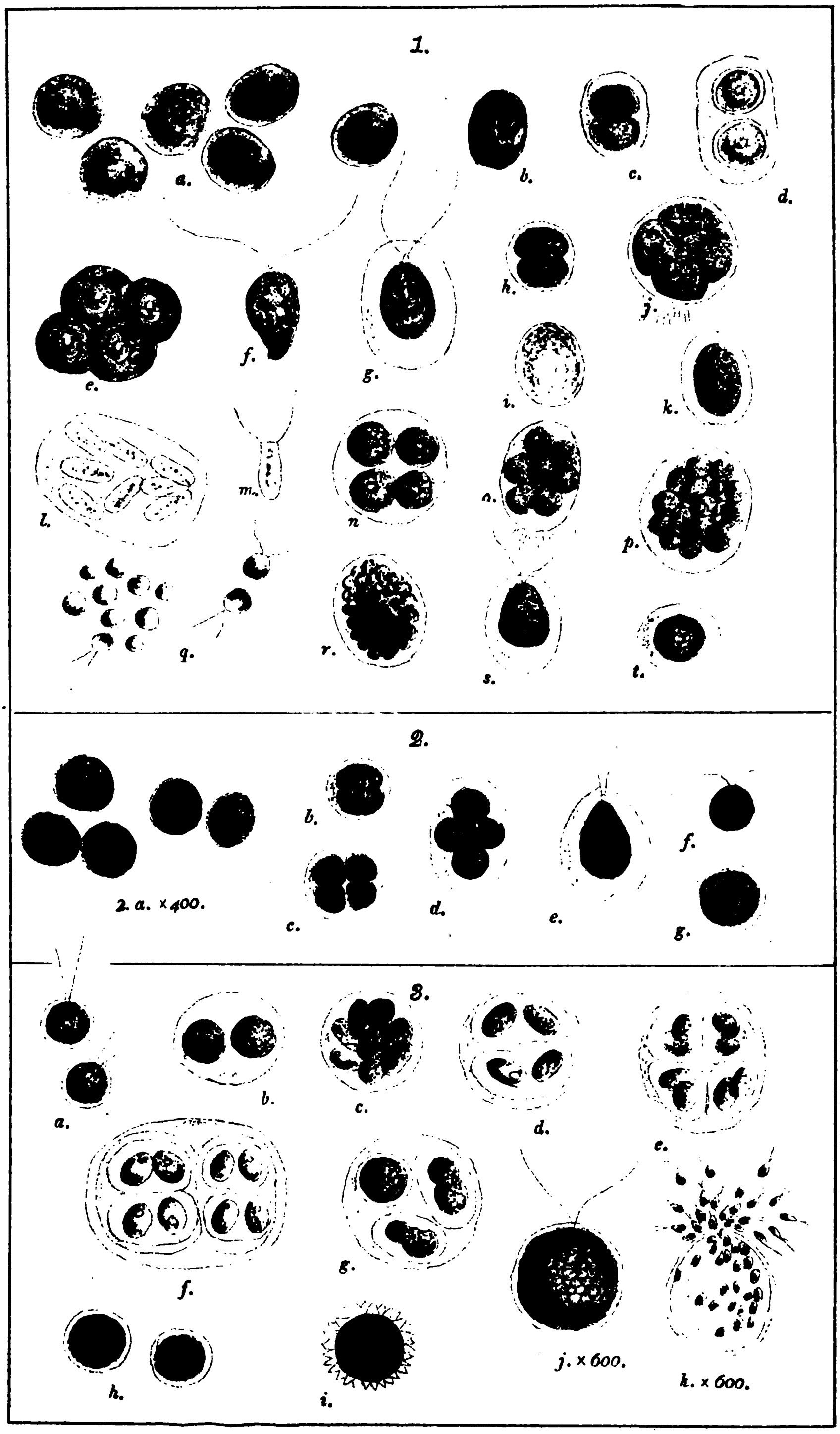
Stephanosphæra pluvialis. Cohn.



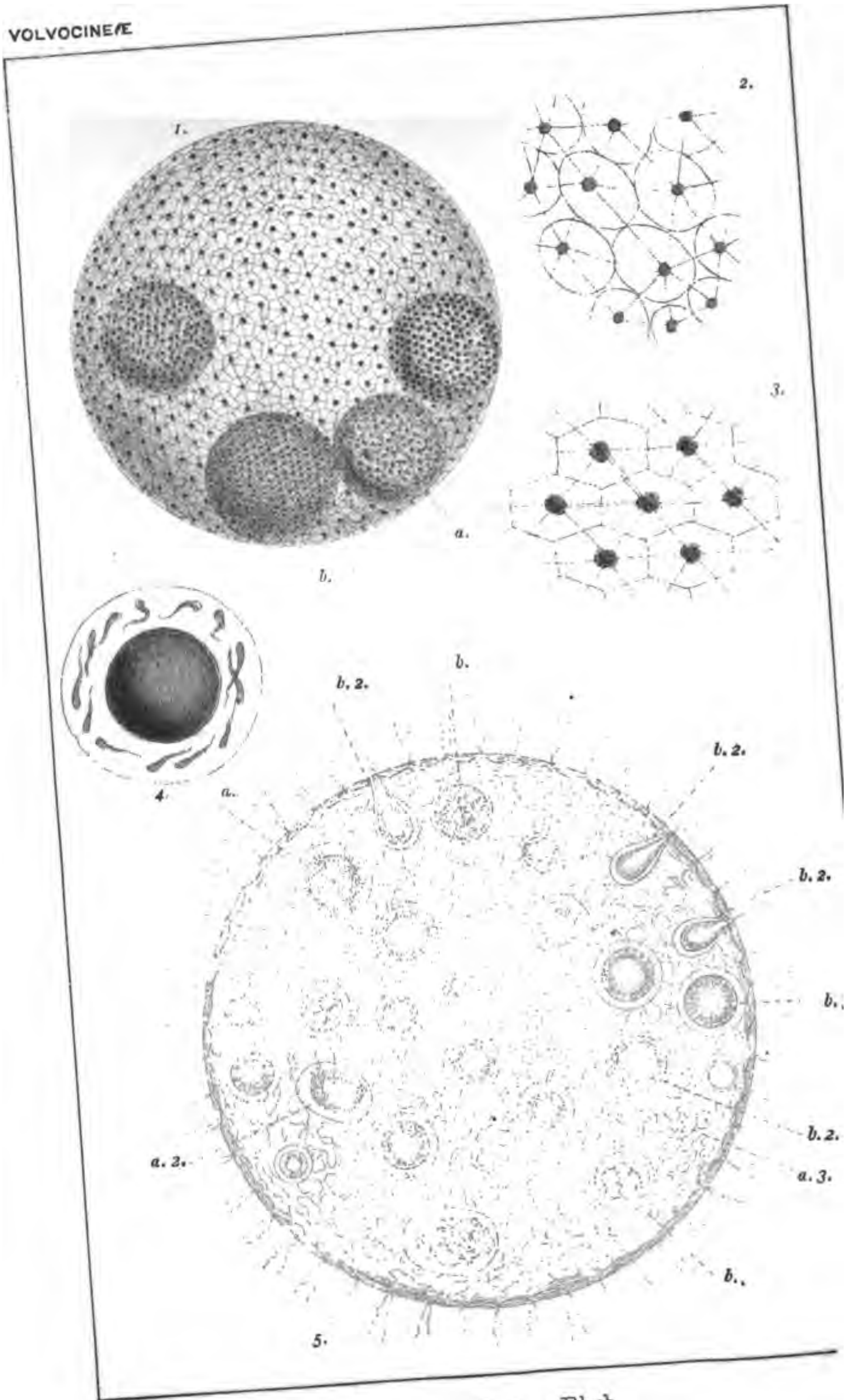
1 Zygnema pectinatum Ag. 2. Zygnema Ralfsii Hass.
3 Zygnema parvulum. Kutz



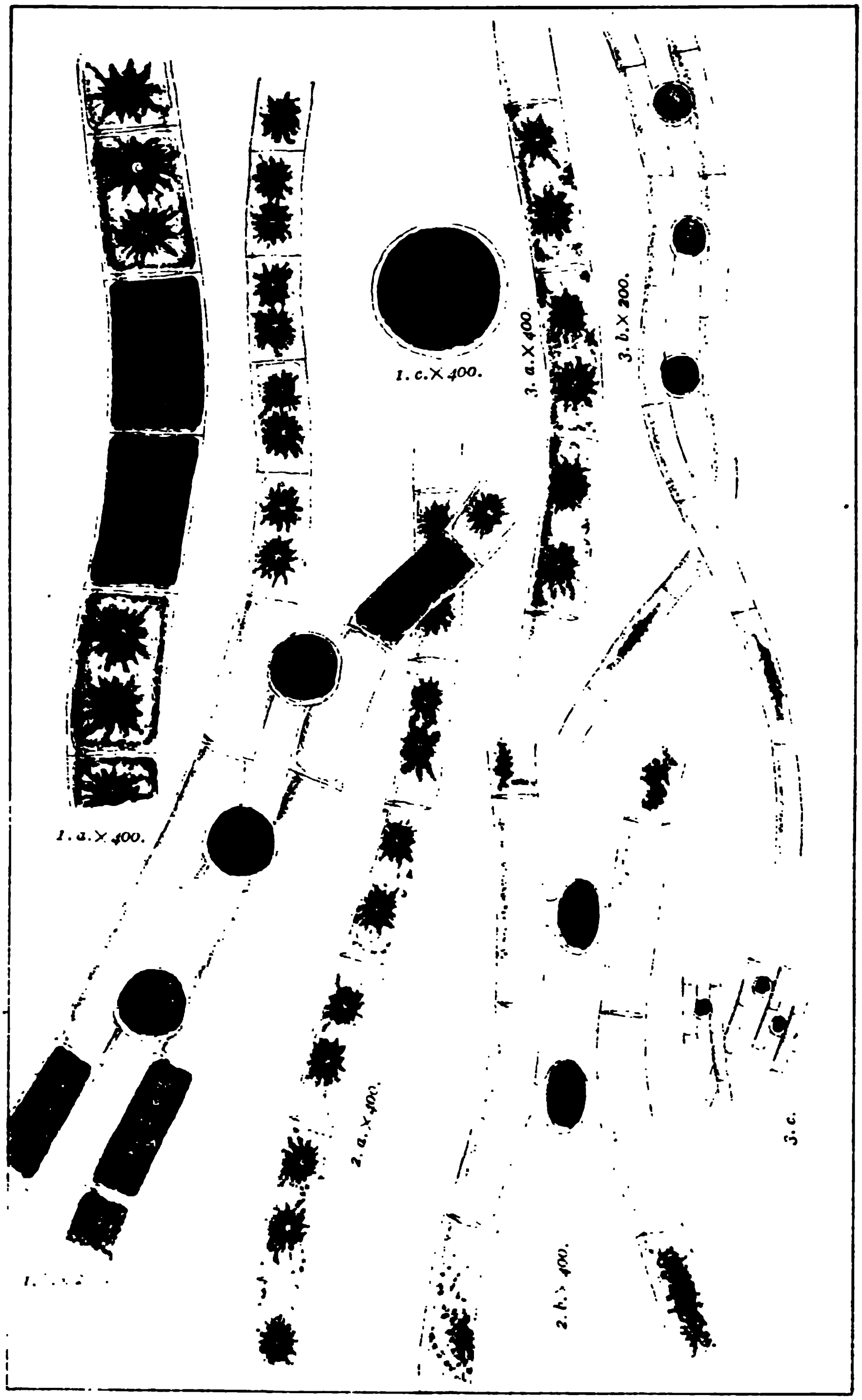
1. *Zygnema cruciatum.* Ag. 2. *Zygnema stellinum.* Vauch.
3. *Zygnema Vaucheri.* Ag. 4. var. subtile. 5. var. stagnal



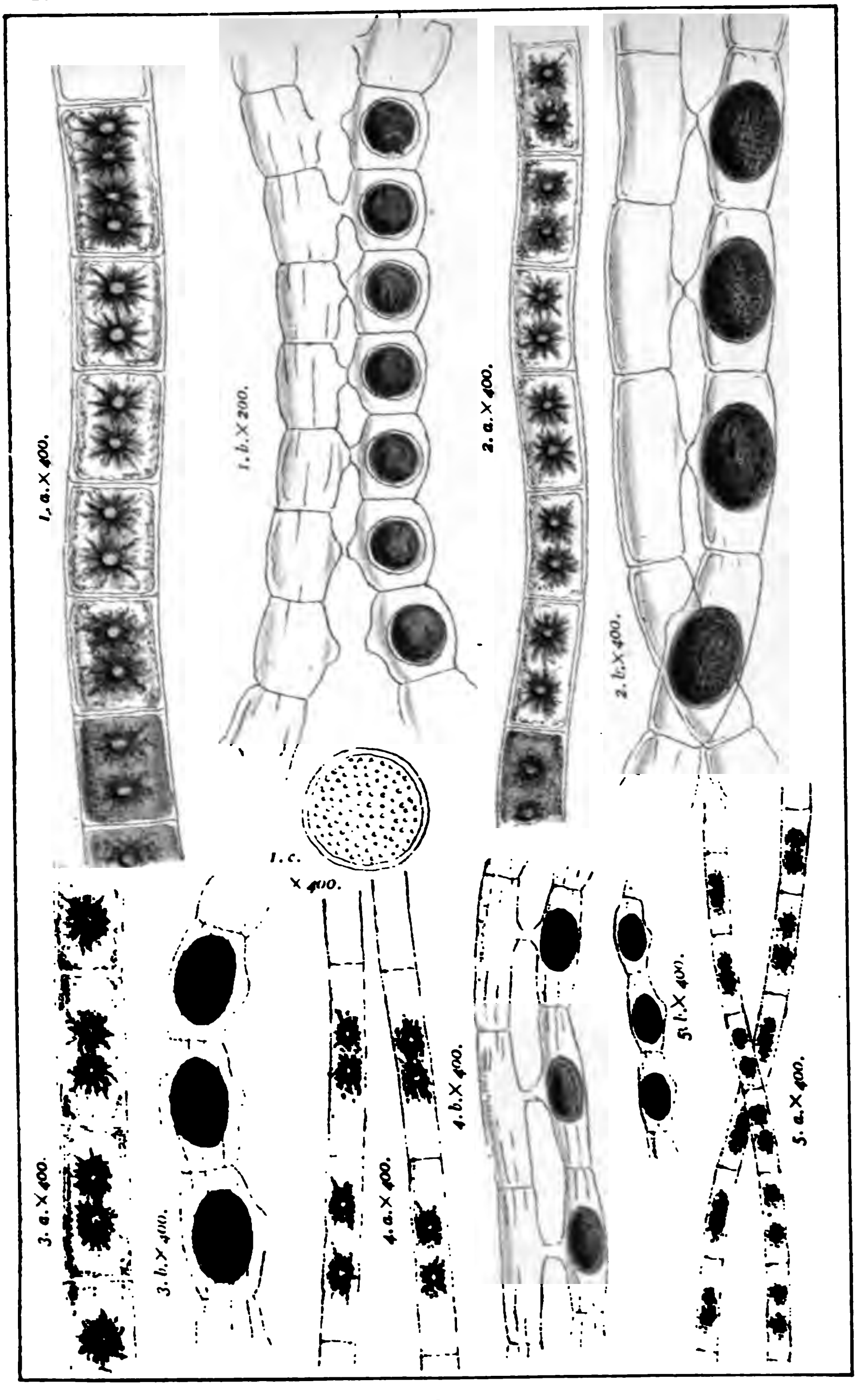
1. *Chlamydococcus pluvialis.* Br. 2. Chlamydococcus nivalis. Br.
3. *Chlamydomonas pulvisculus.* Ehrb.



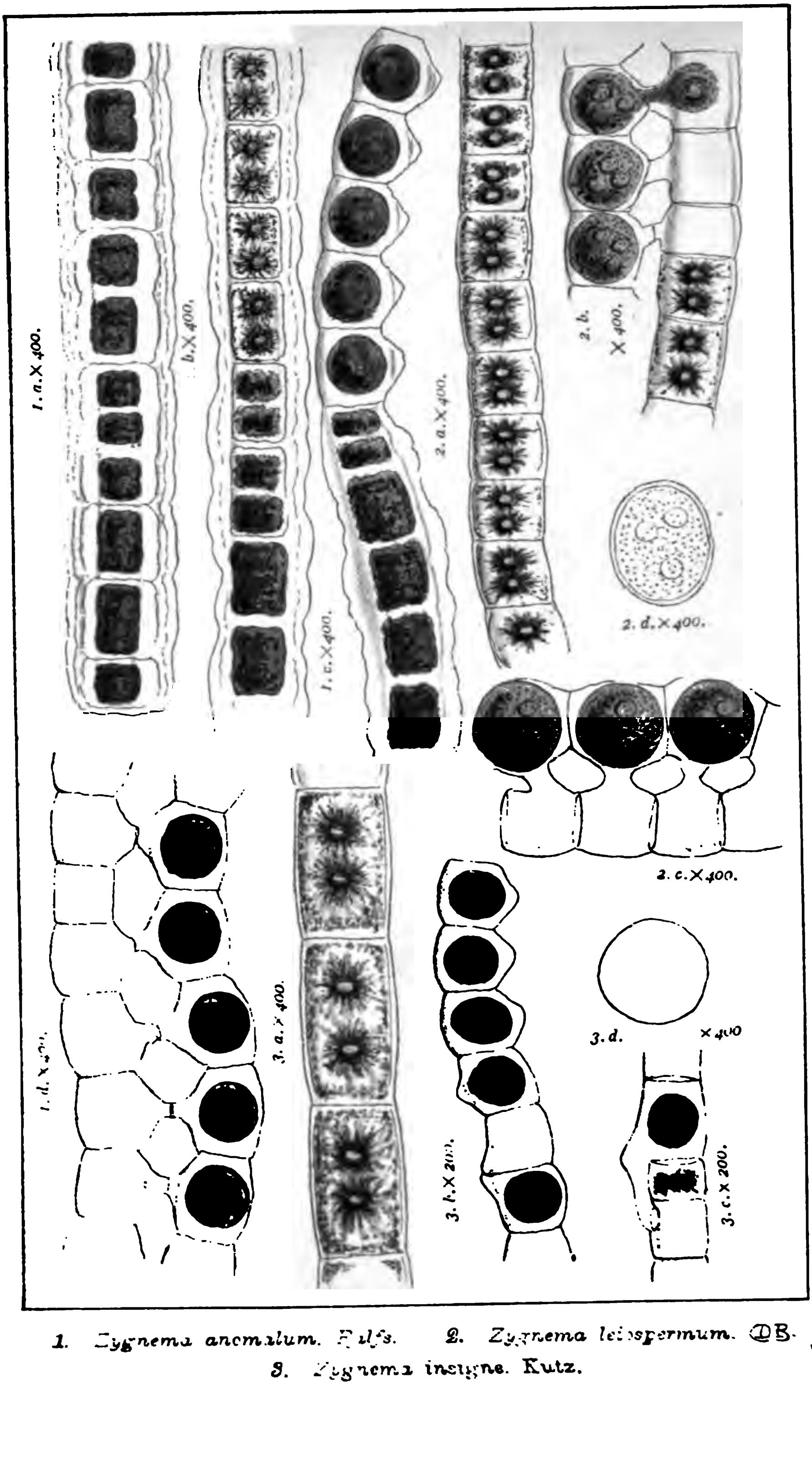
Volvox globator. Ehrb.



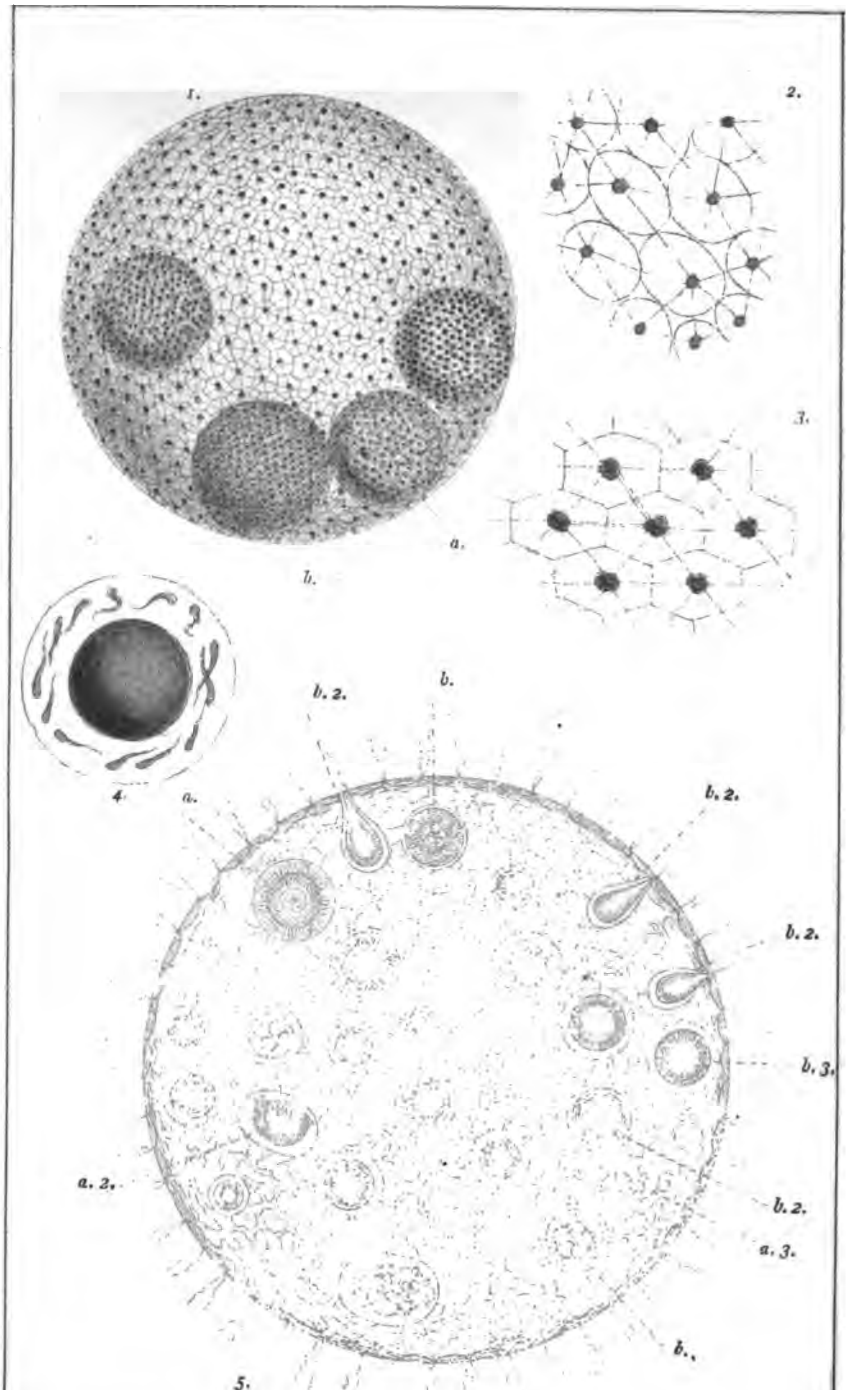
1. Zygnema pectinatum Ag. 2. Zygnema Ralfsii. Hass.
3. Zygnema parvulum. Kutz.



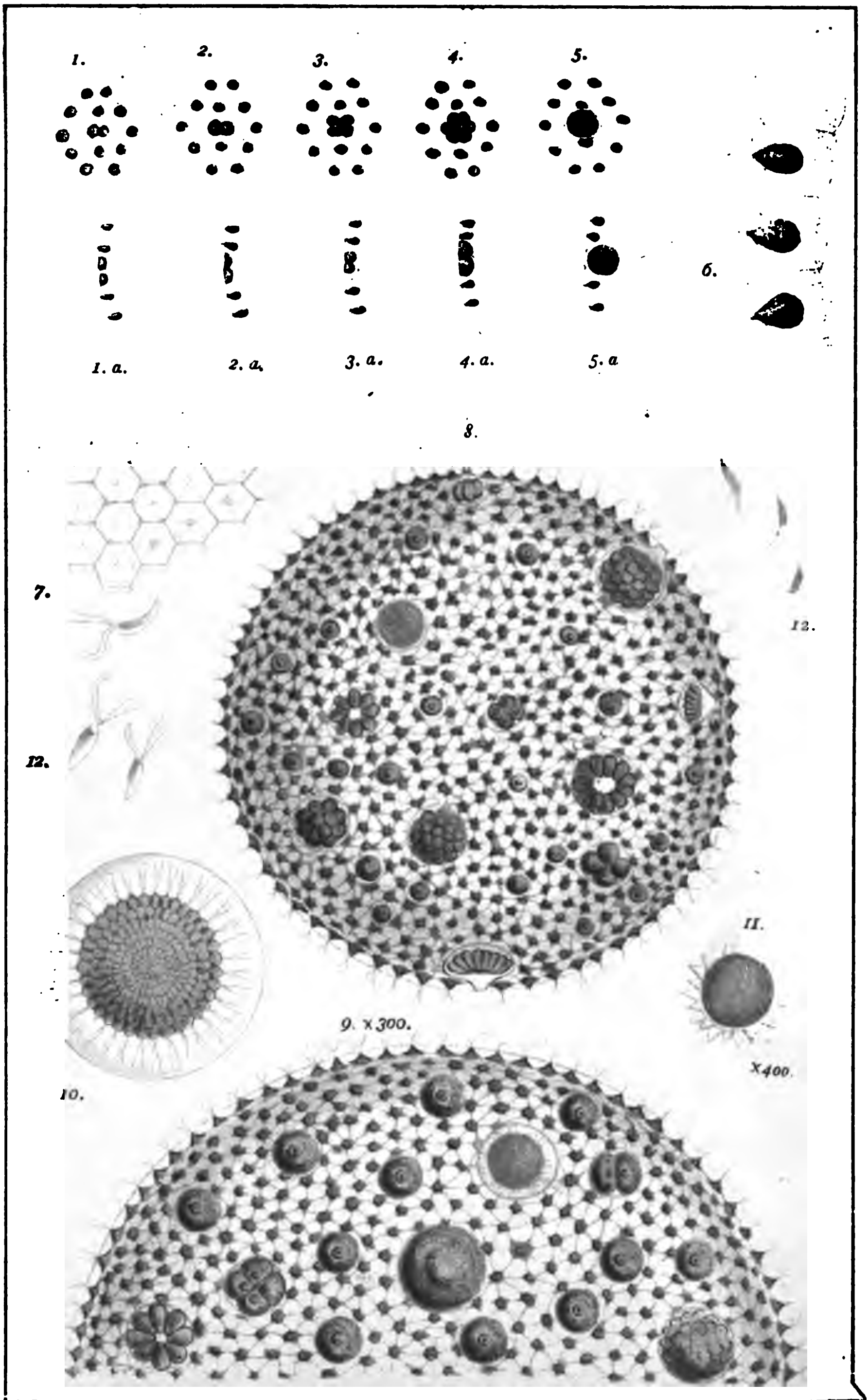
1. Zygnema cruciatum. Ag. 2. Zygnema stellinum. Vauch.
3. Zygnema Vaucheri. Ag. 4. var. subtile. 5. var. stagnal



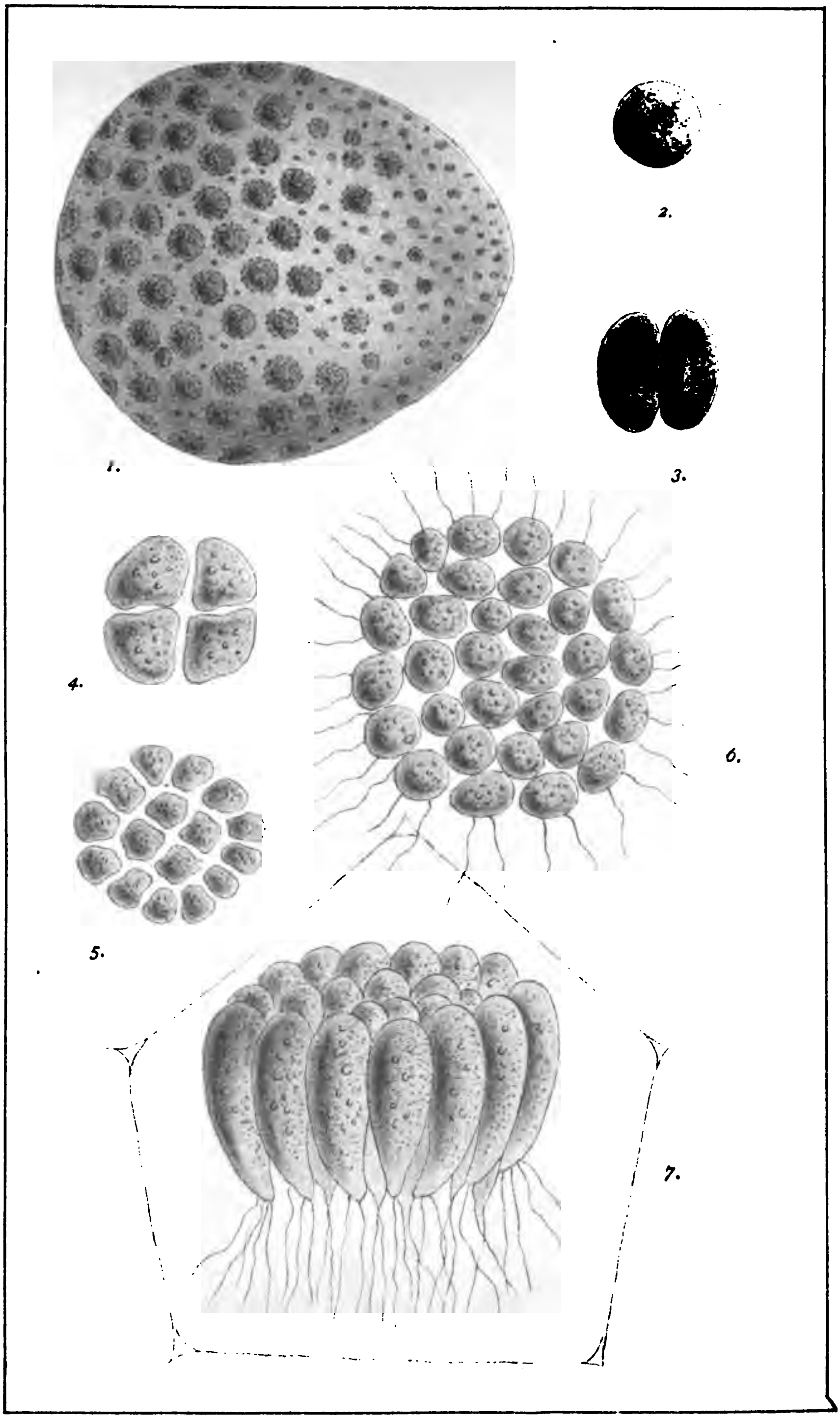
1. Zygnema anomalum. Ralfs. 2. Zygnema leiospermum. DB.
3. Zygnema insigne. Kutz.



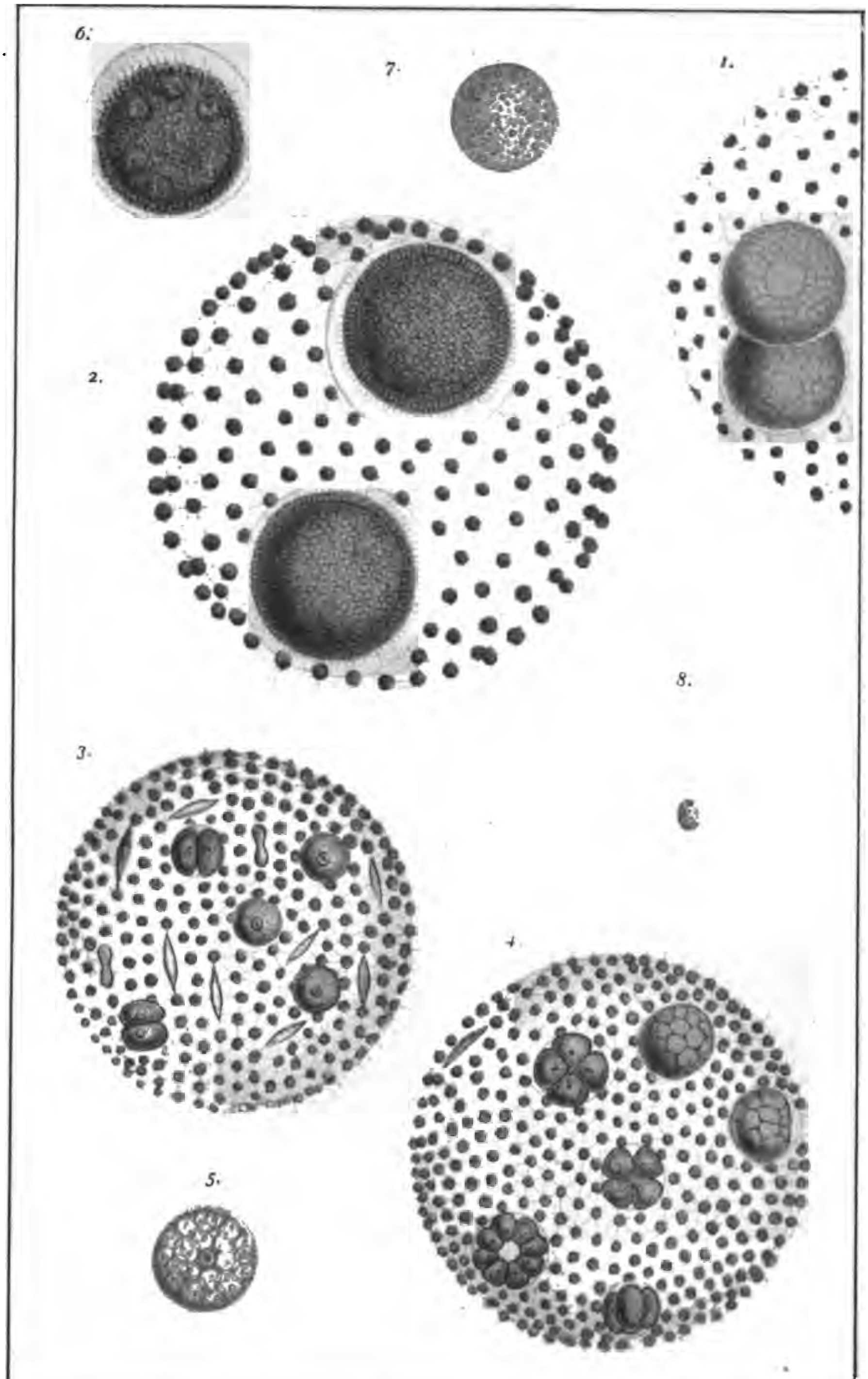
Volvox globator. Ehrb.



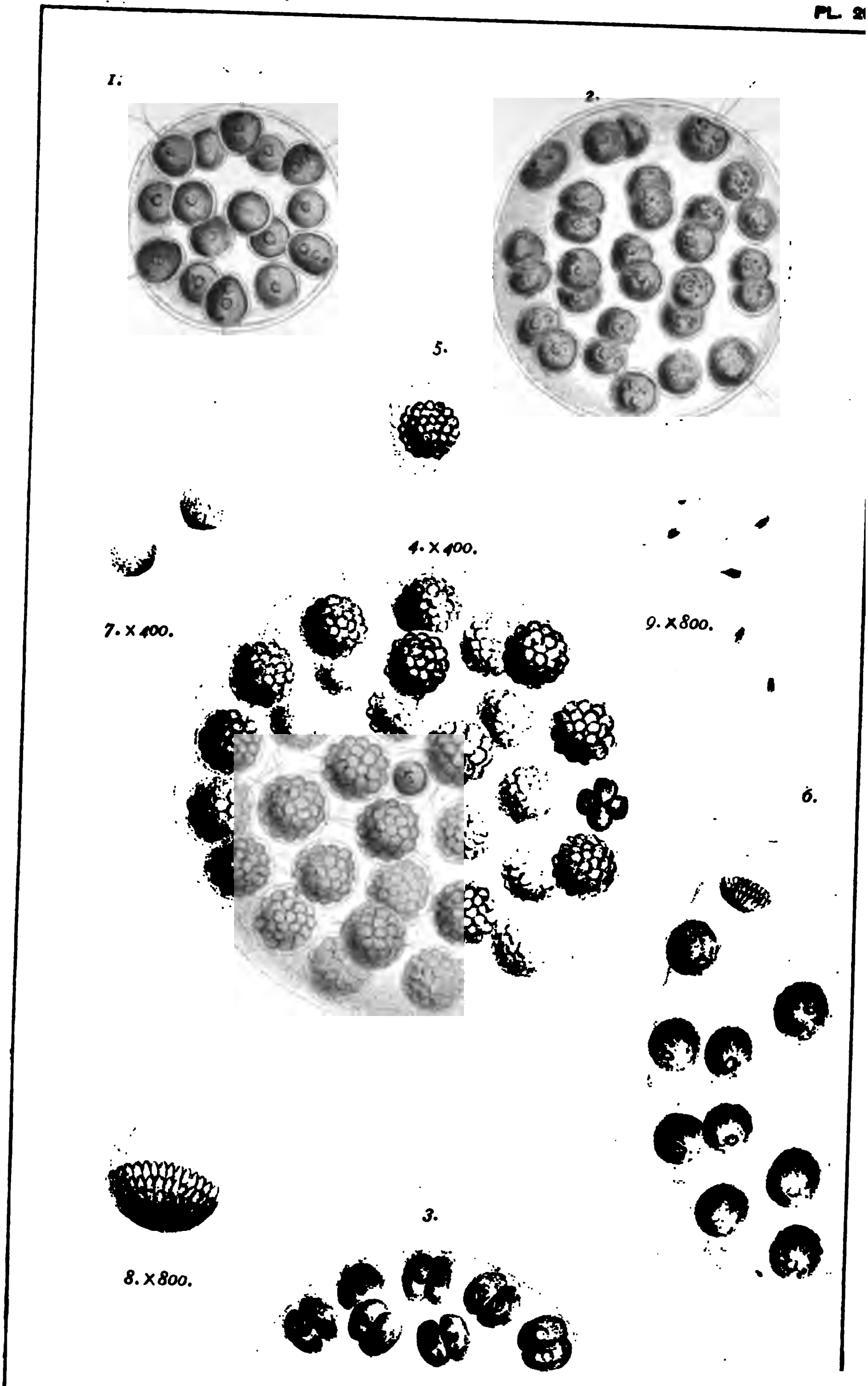
Volvox globator. Ehr.



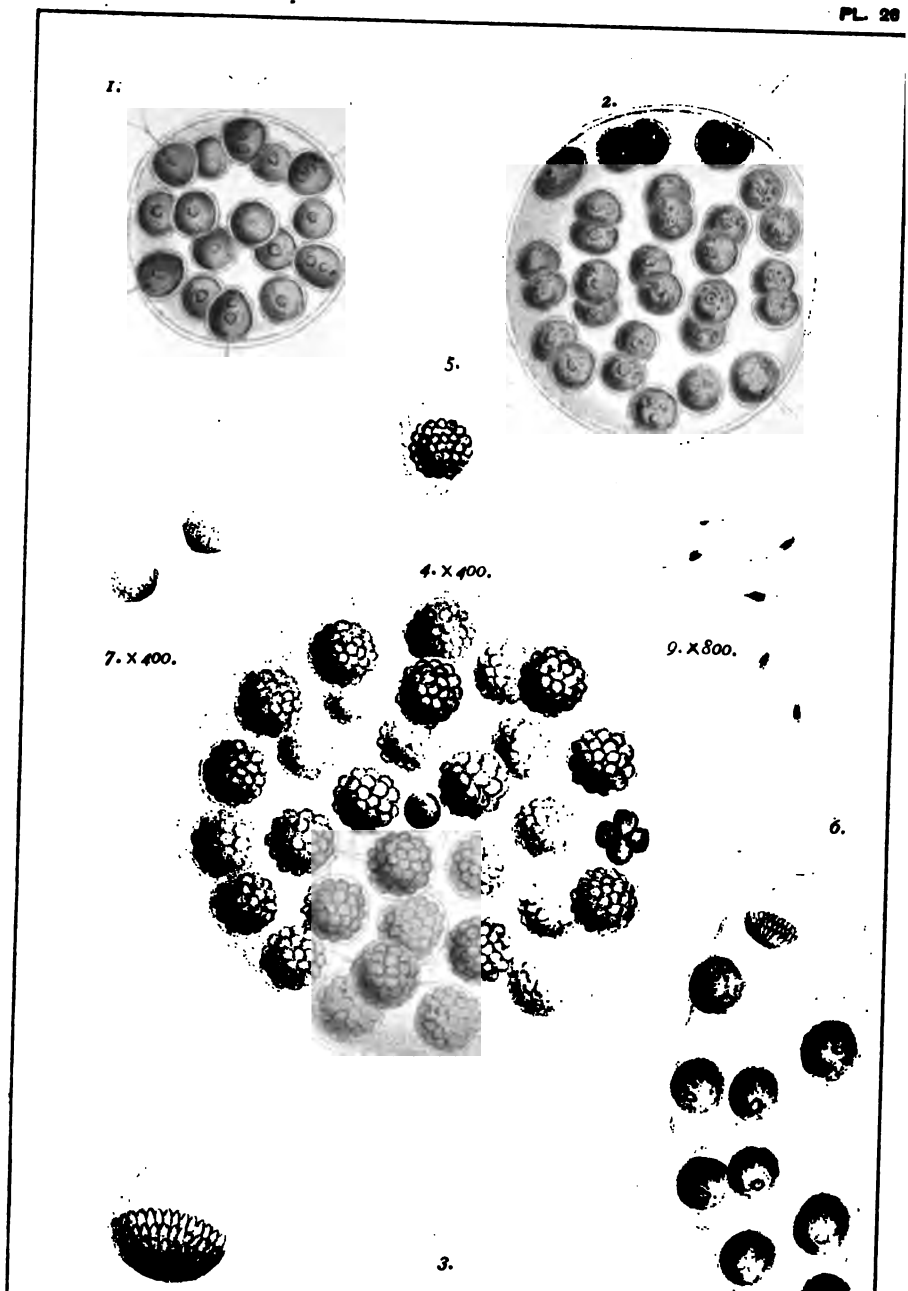
Volvox globator. ♂ (*Sphærosira volvox* Ehr.)



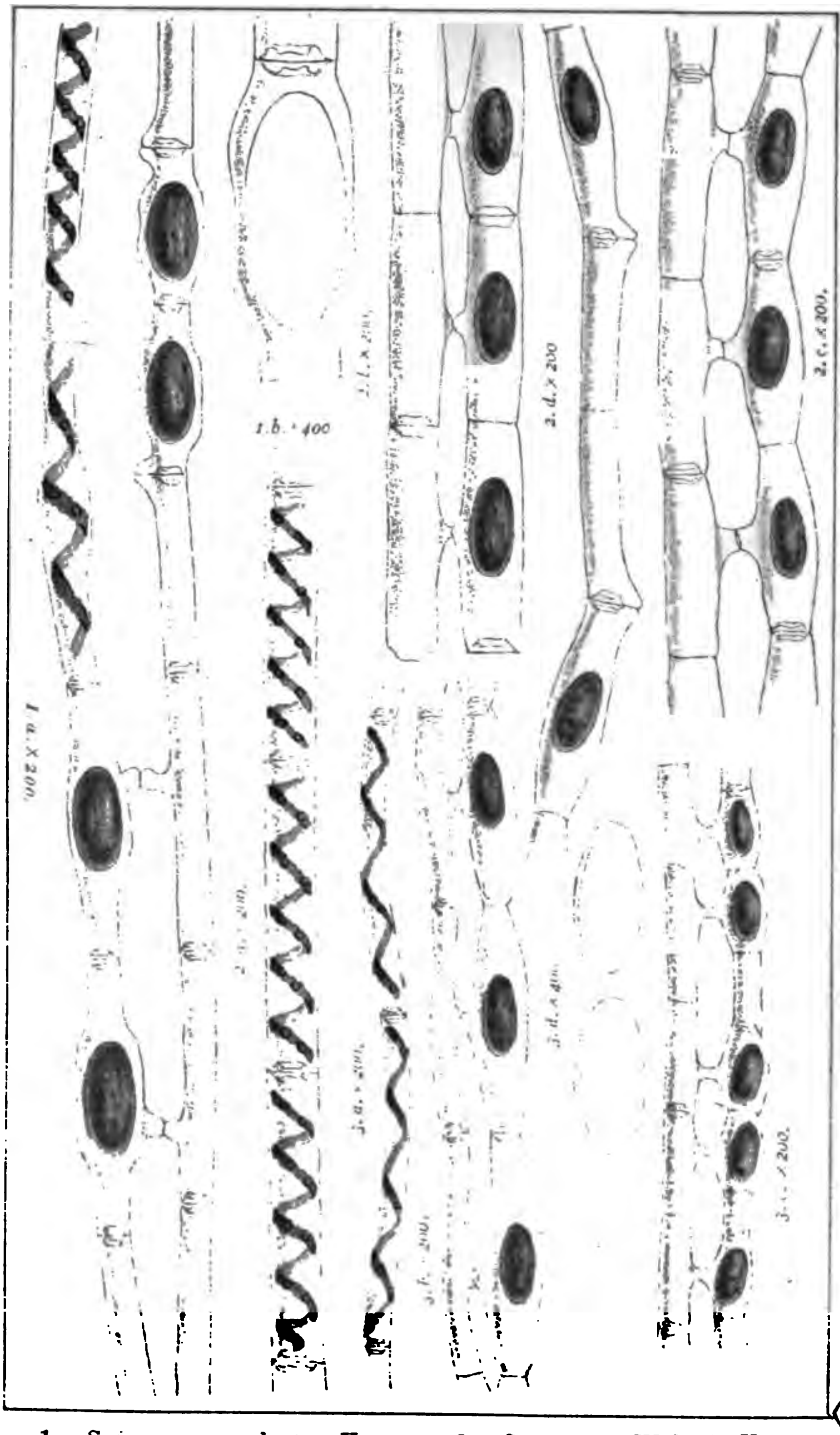
Volvox minor. Stein.



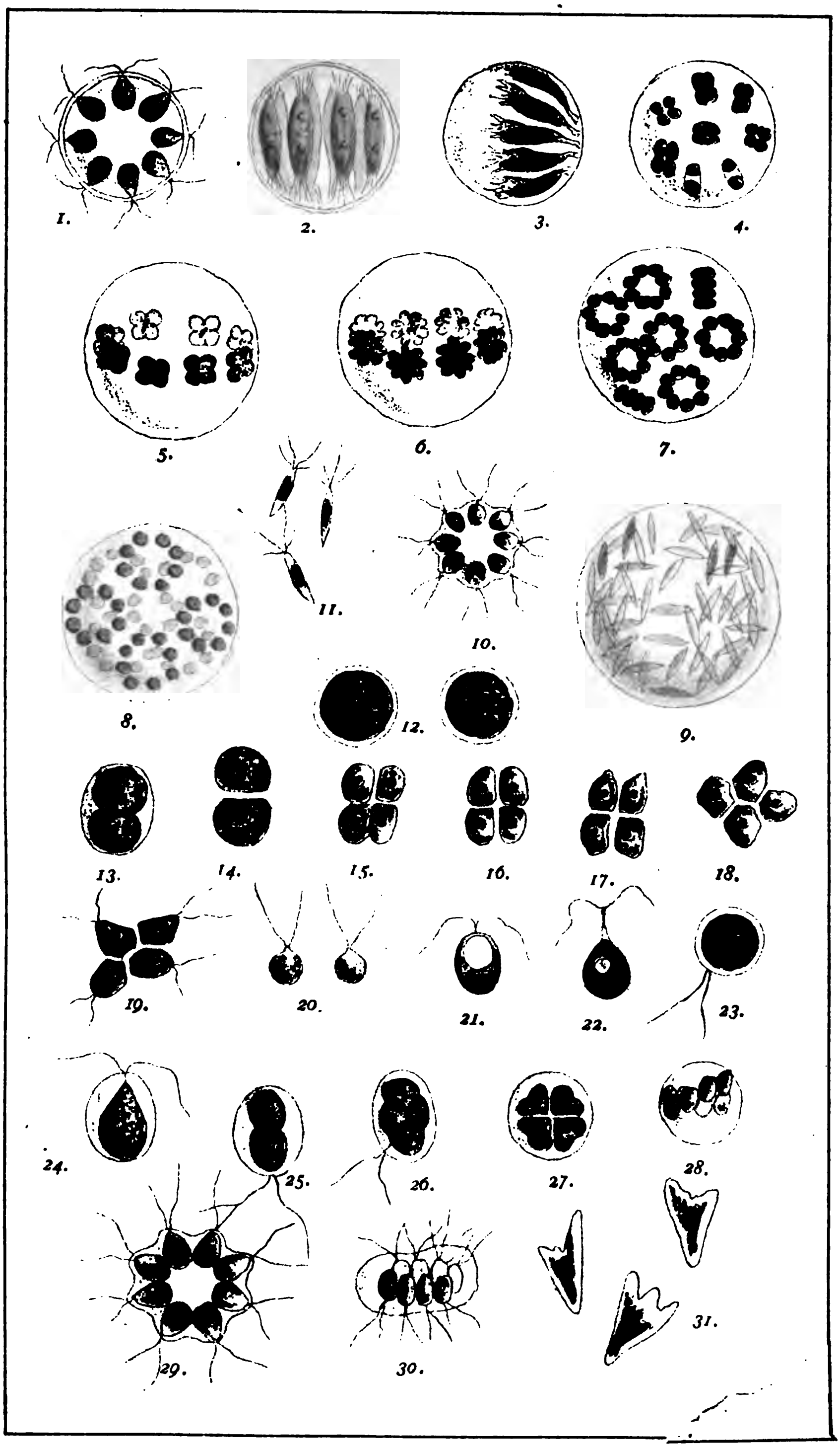
Eudorina elegans. Ehrb.



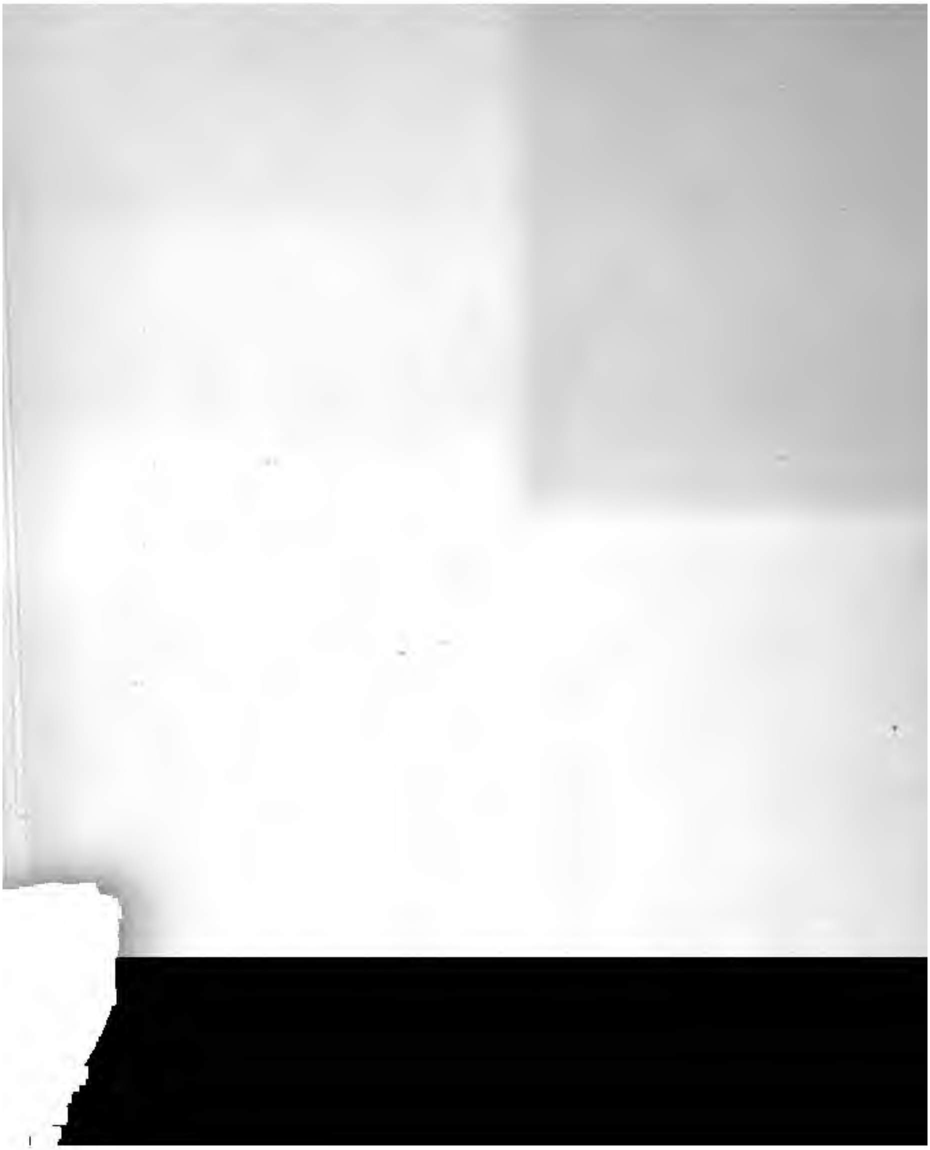
Eudorina elegans. Ehrb.

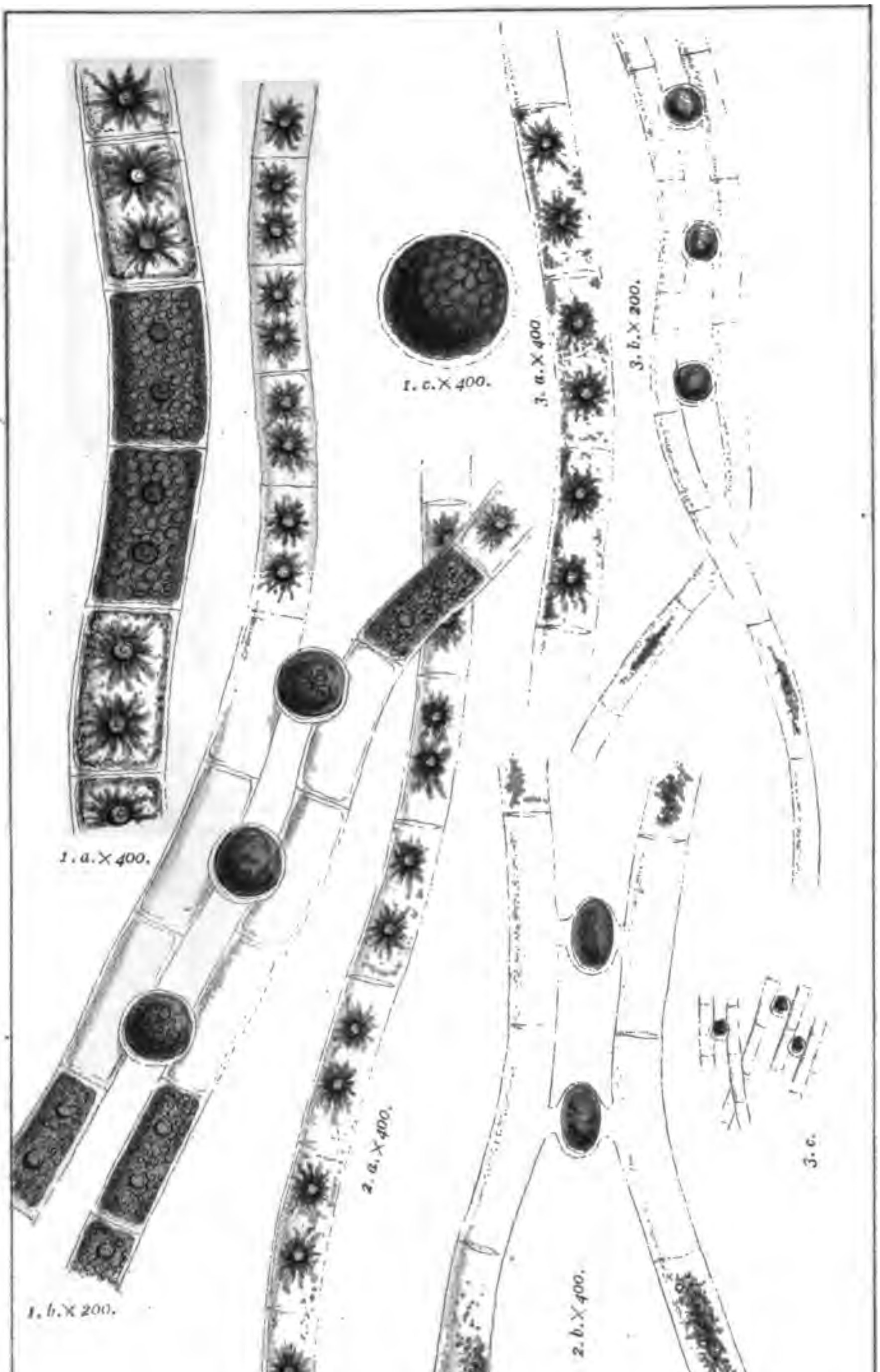


1. *Spirogyra quadrata. Hass.* 2. Spirogyra Weberi. Kutz.
3. *Spirogyra tenuissima.* Hass.

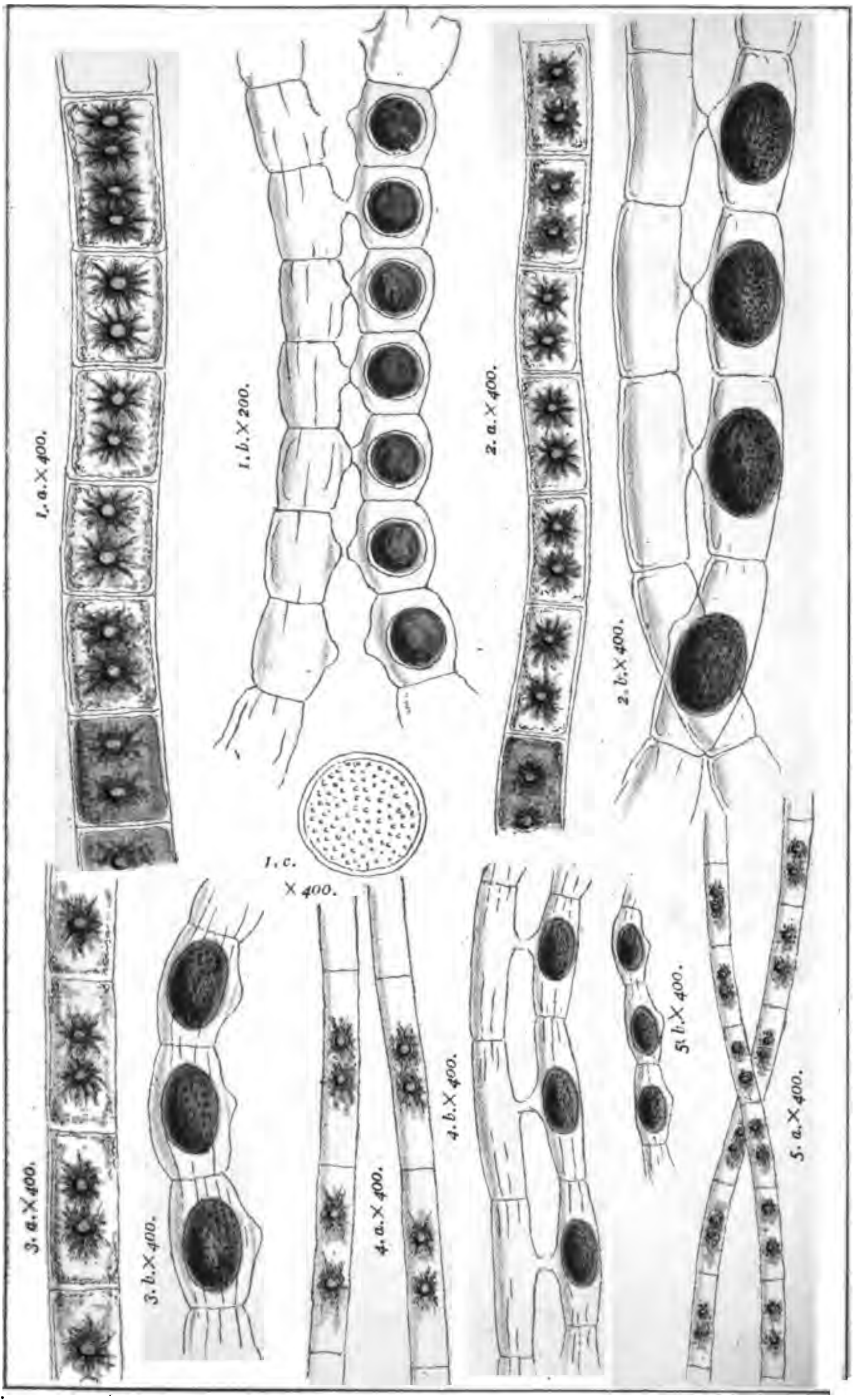


Stephanosphæra pluvialis. Cohn.

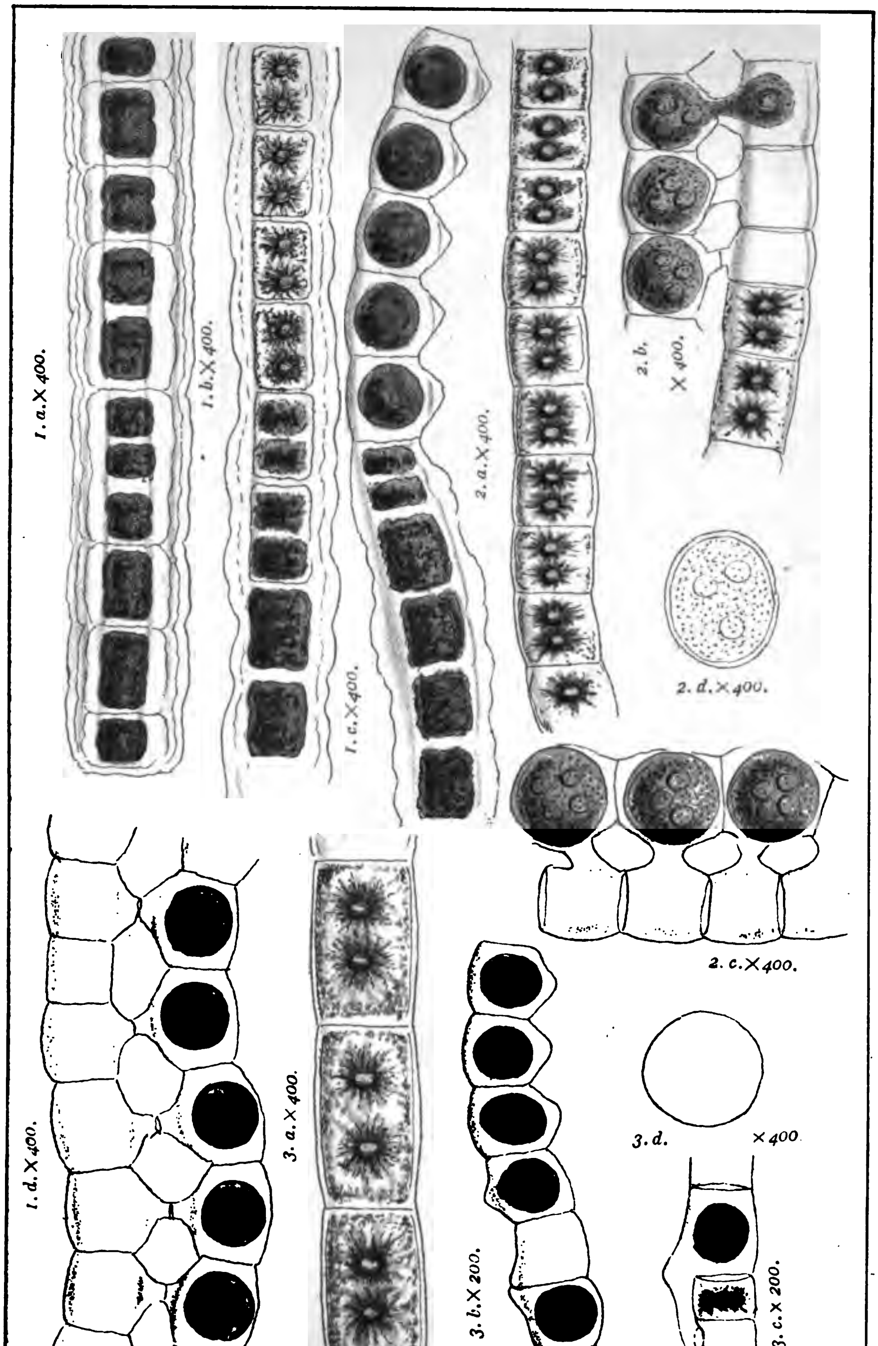




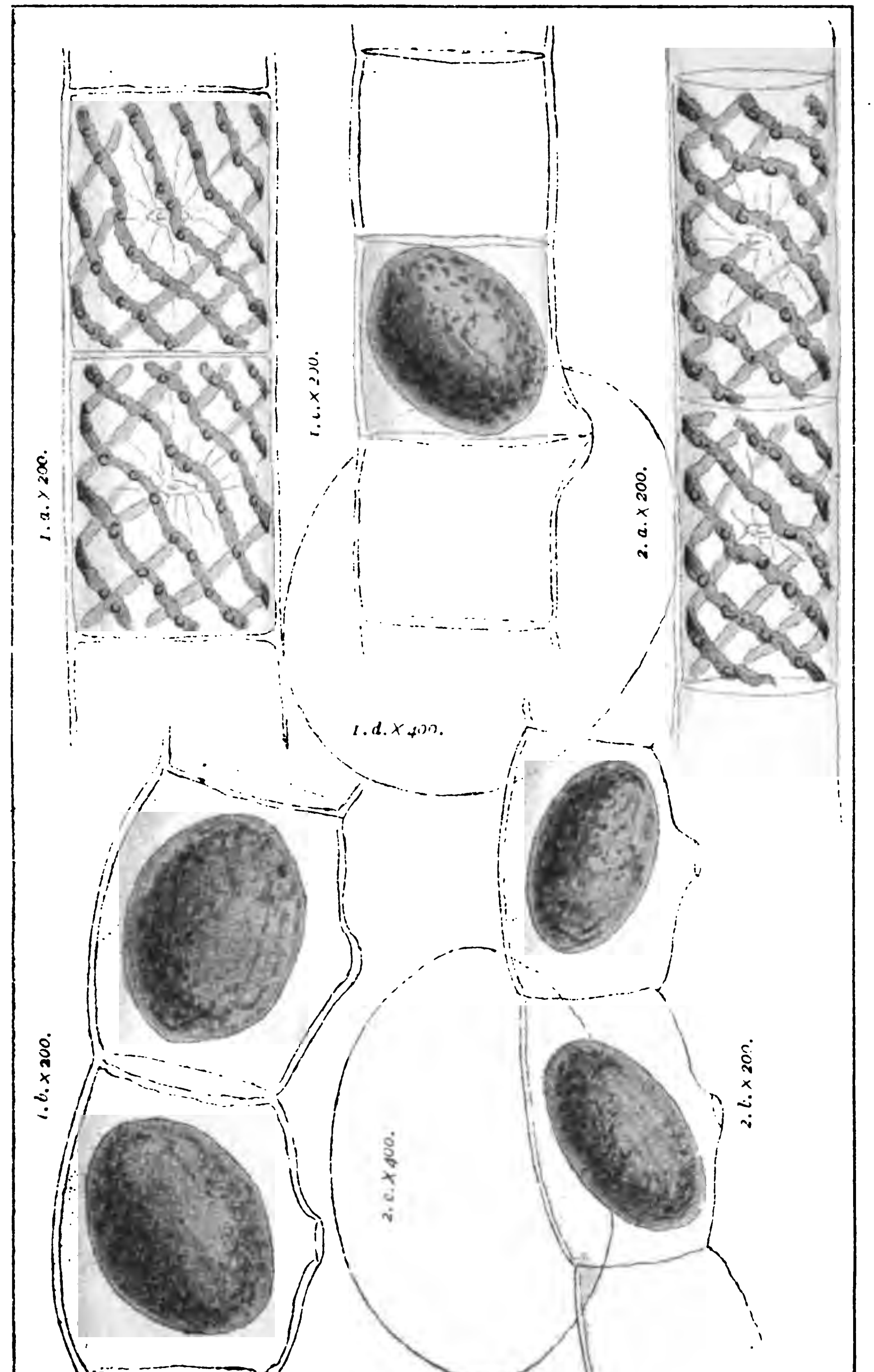
1. *Zygnema pectinatum. Ag.* 2. *Zygnema Ralfsii. Hass.*
3 *Zygnema parvulum. Kutz.*



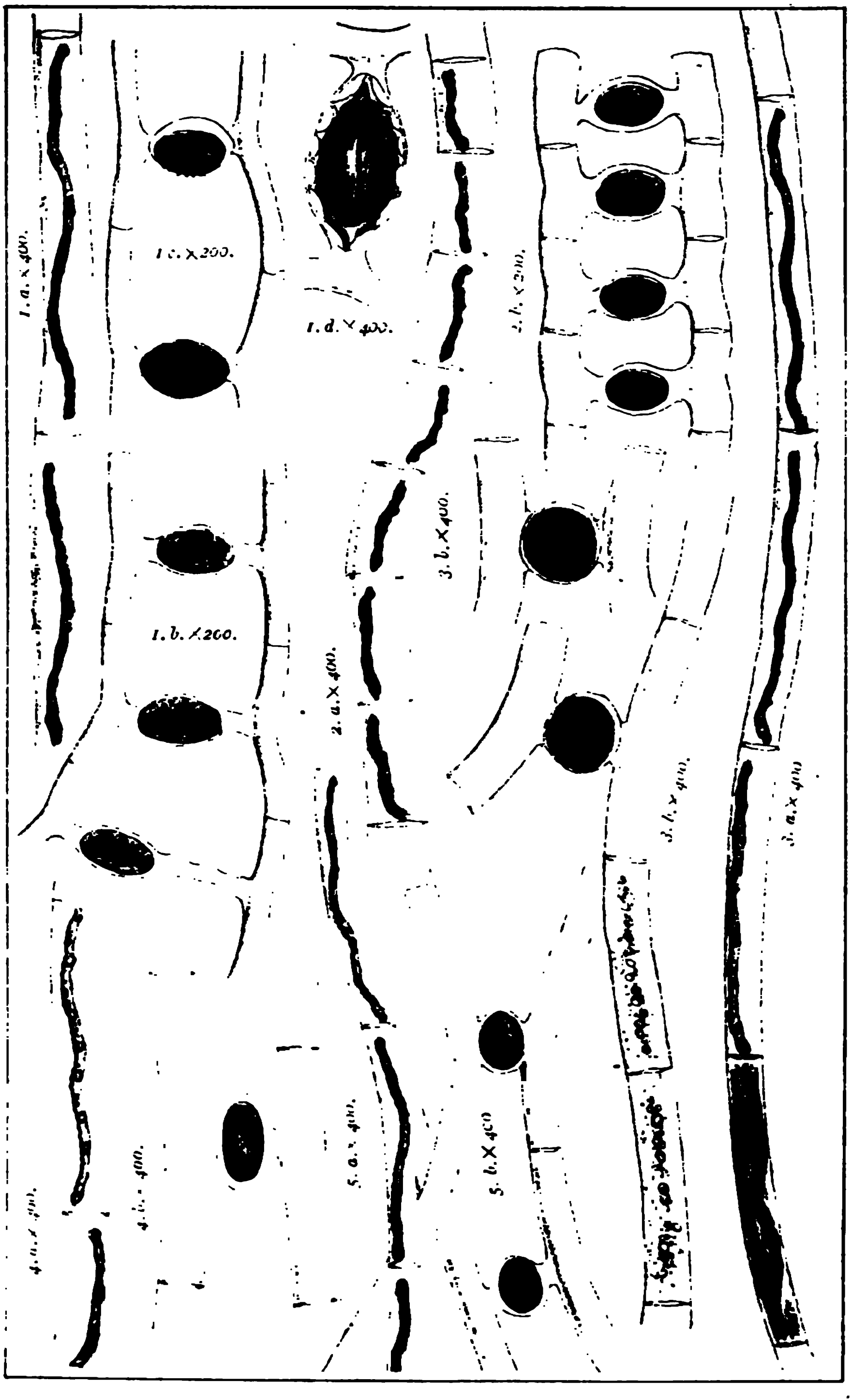
1. *Zygnema cruciatum. Ag.* 2. *Zygnema* stellinum. Vauch.
3. *Zygnema Vaucheri. Ag.* 4. var. subtile. 5. var. stagnal



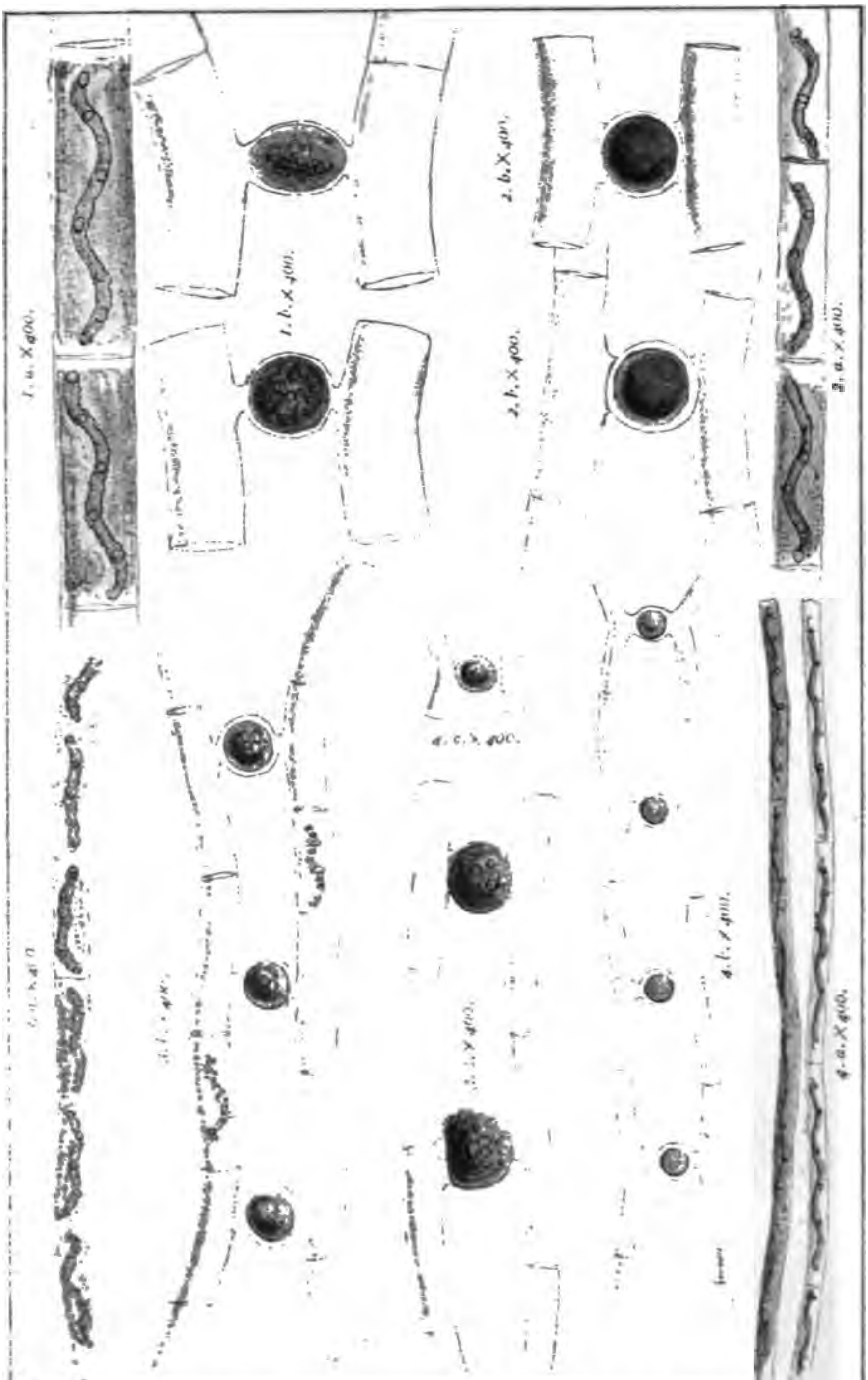
1. *Zygnema anomalum*. Ralfs. 2. *Zygnema leiospermum*. DB.
3. *Zygnema* insi . K



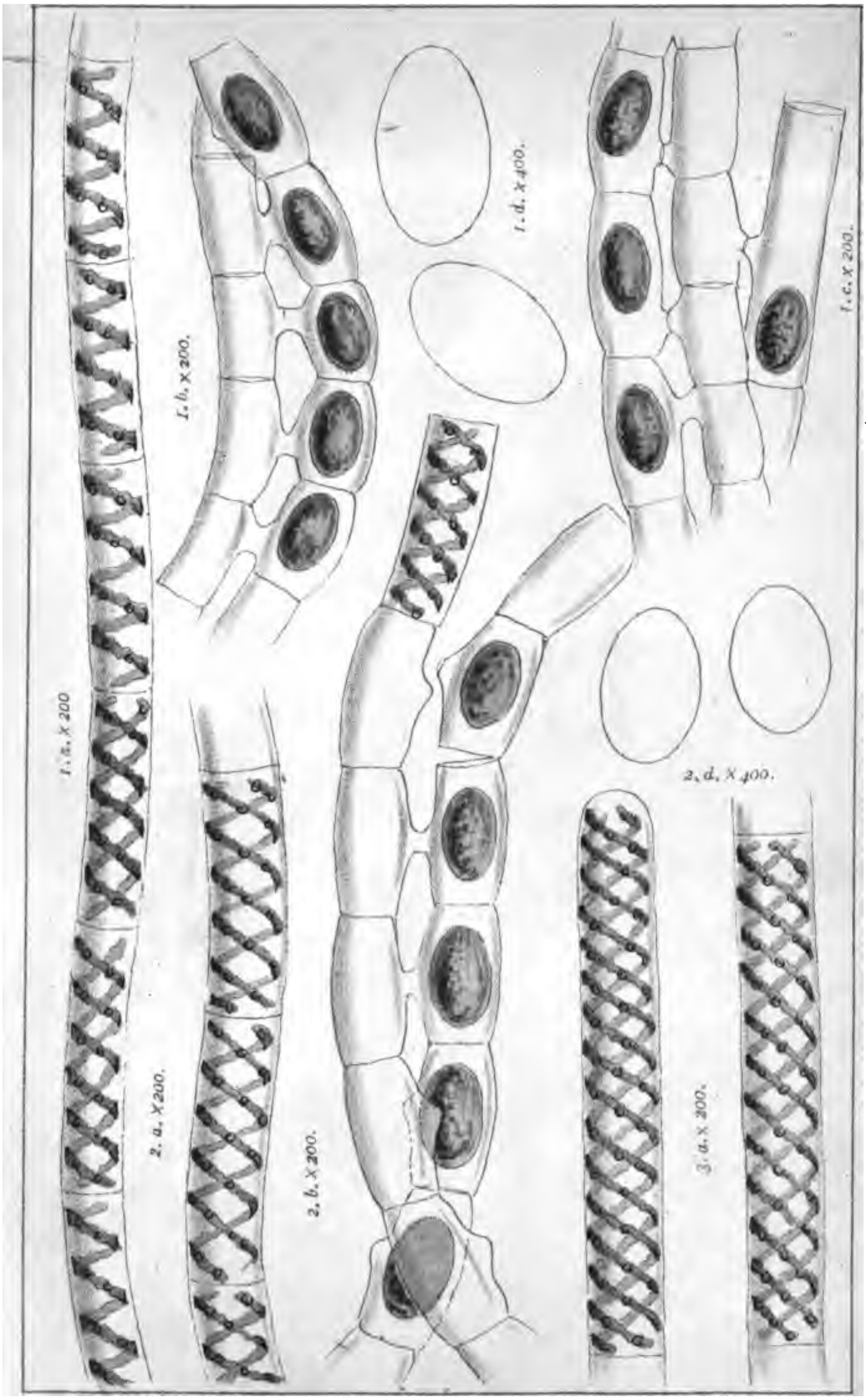
1. *Spirogyra crassa. Kutz.* 2. Spirogyra jugalis. Dillw.



1. *Mougeotia glyptosperma. DBy.*
2. *Mougeotia lævis. Archer.*
3. *Mesocarpus nummuloides. Hass.*
4. *Mesocarpus depressus. Hass.*
5. *Mesocarpus depressus, var. ovalis.*

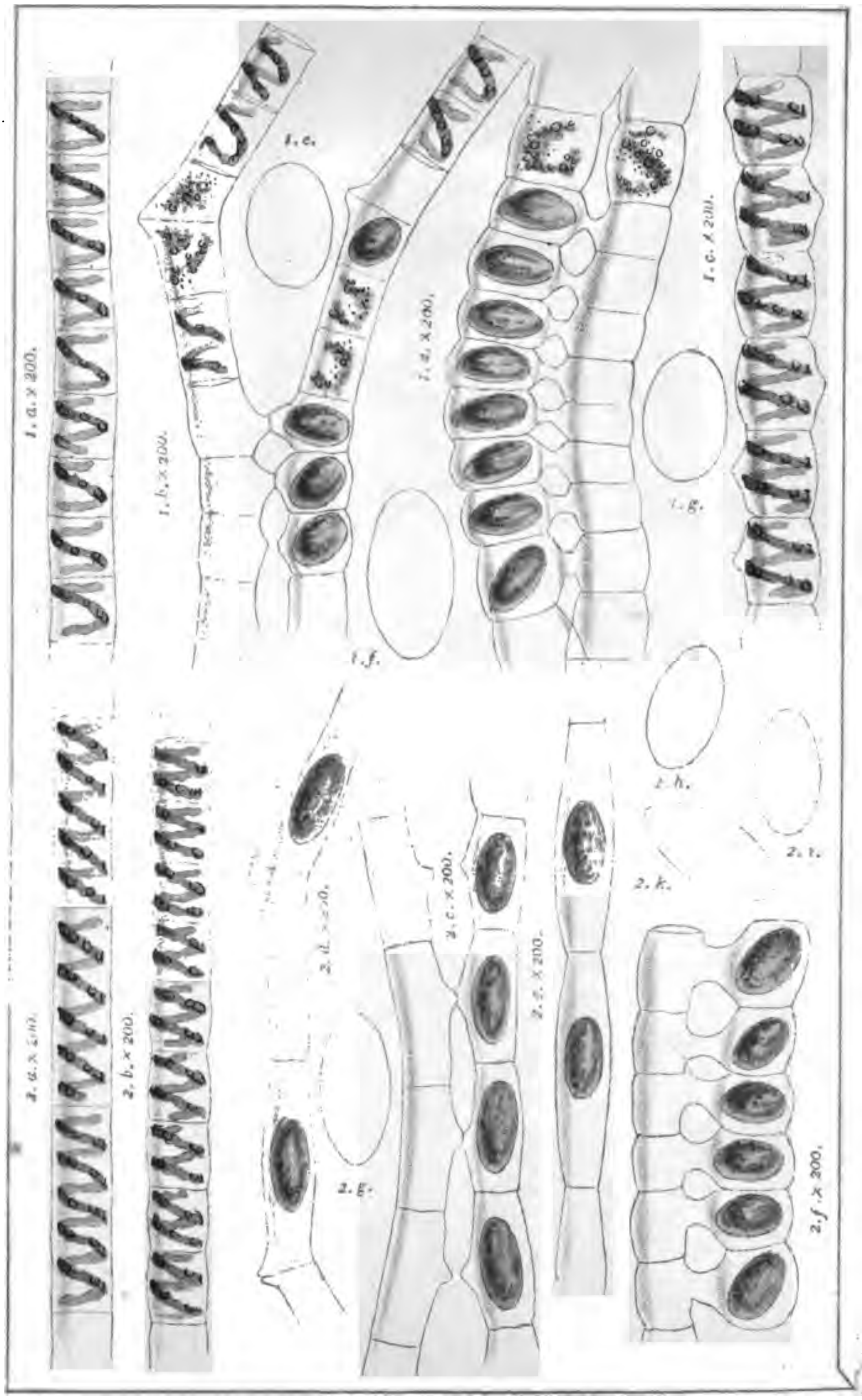


1. Mesocarpus scalaris. Hass.
3. Mesocarpus recurvus. Hass.
2. Mesocarpus parvulus. Hass.
4. M. parvulus, var. angustus. Hass.

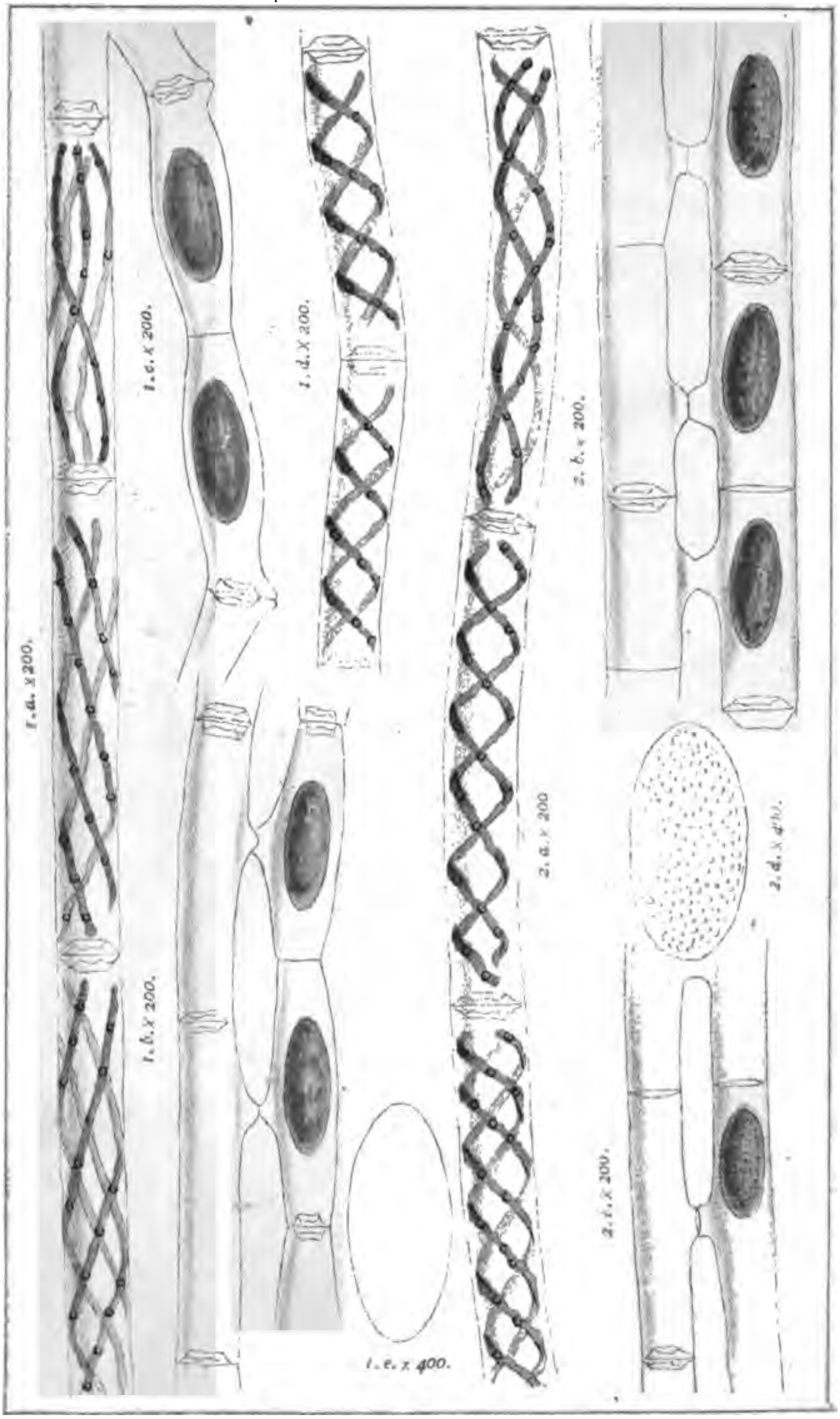


Spirogyra porticalis. Vauch.

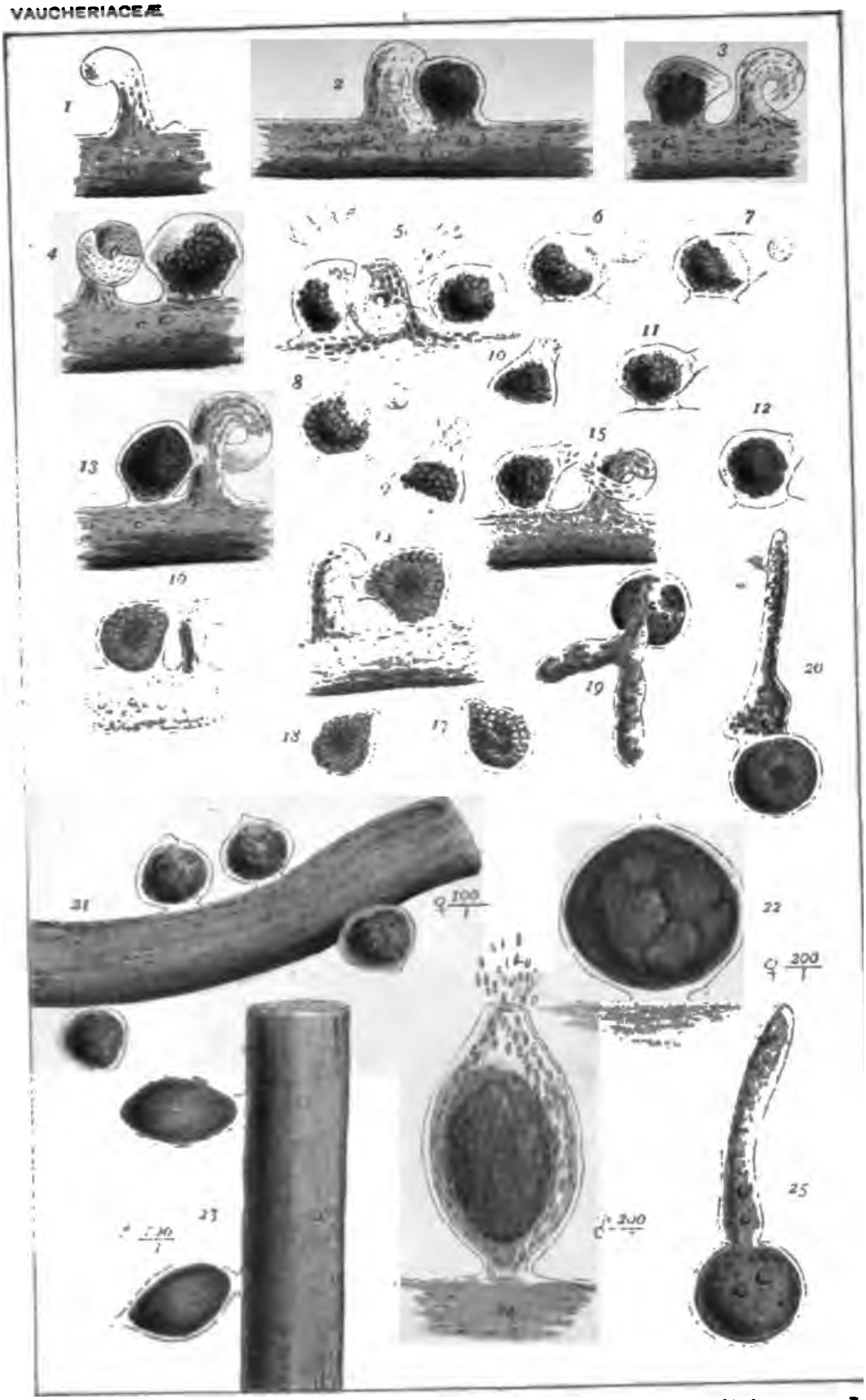
1. *forma quinina.* 2. *forma decimina.* 3. *forma rivularis.*



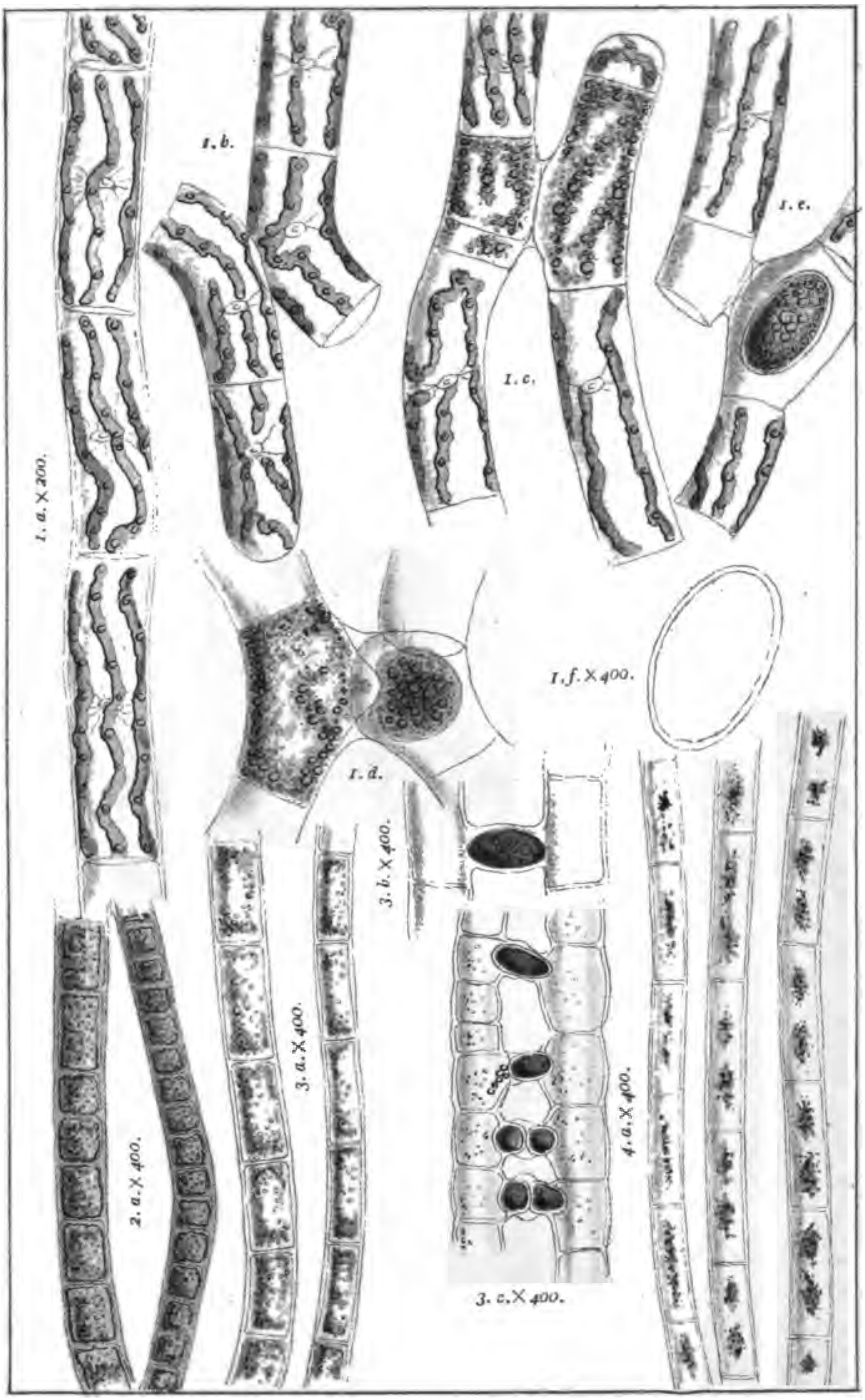
1. *Spirogyra condensata.* *Vauch.* 2. Spirogyra longata. Vauch.



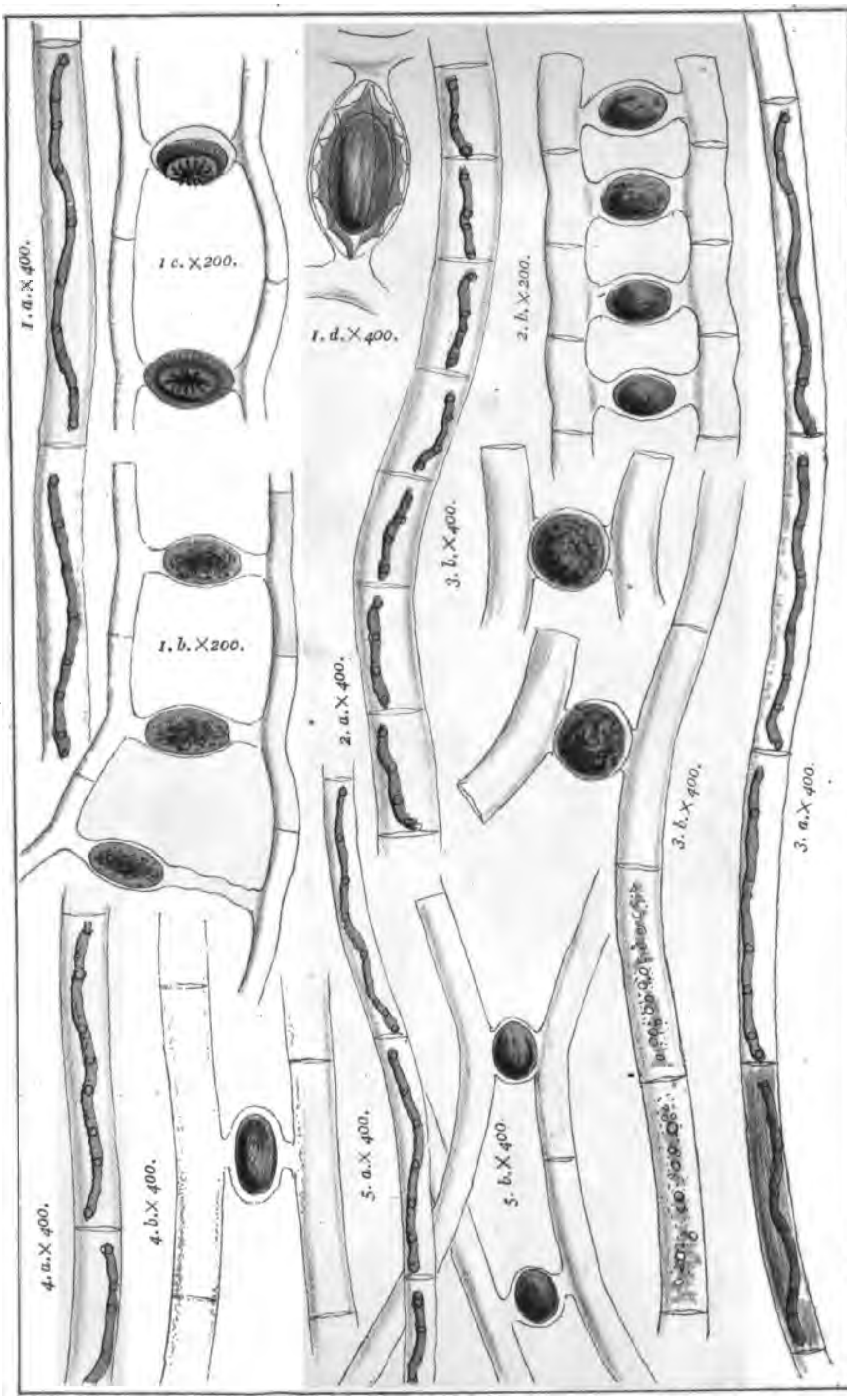
1. *Spirogyra insignis. Hass.* 2. Spirogyra calospora. Cleve.



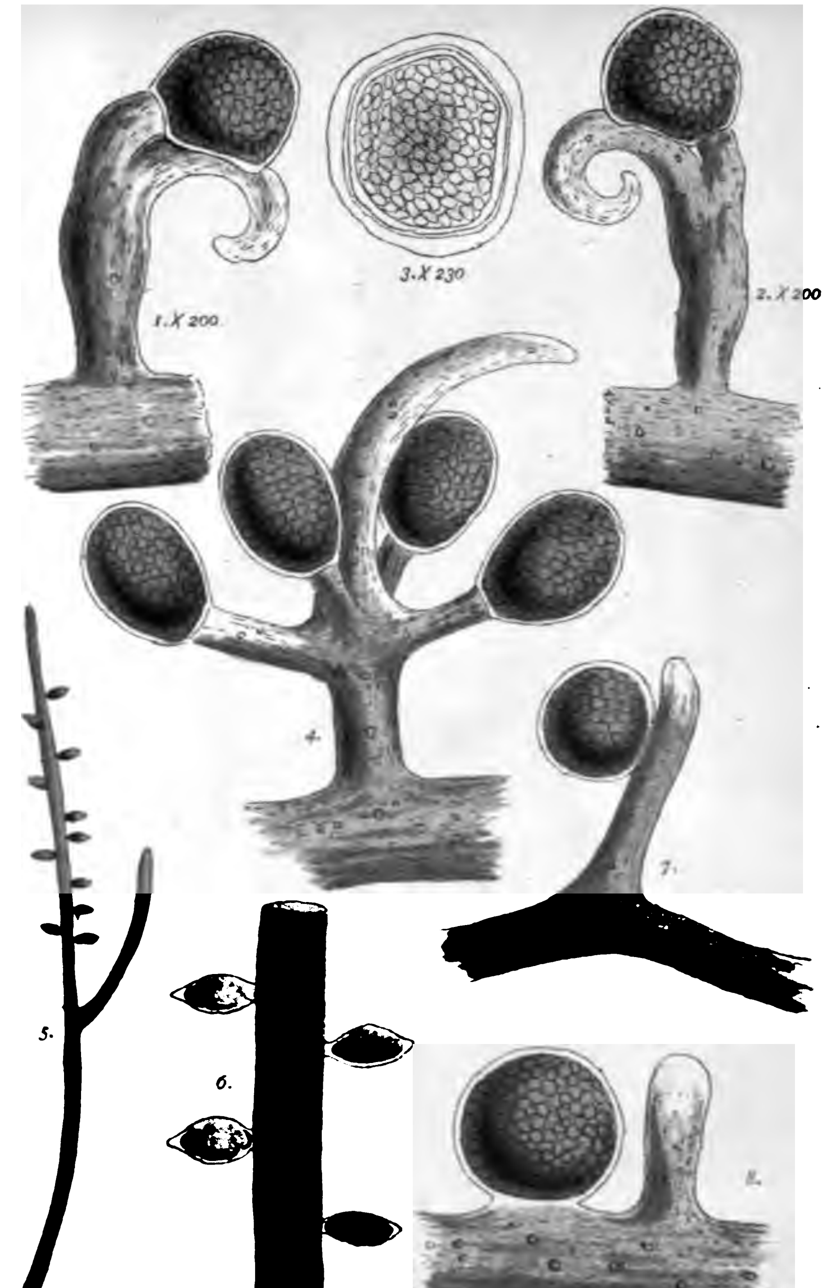
1.-20. Impregnation of Vaucheria sessilis. 21.-25. Vaucheria dichotoma. L



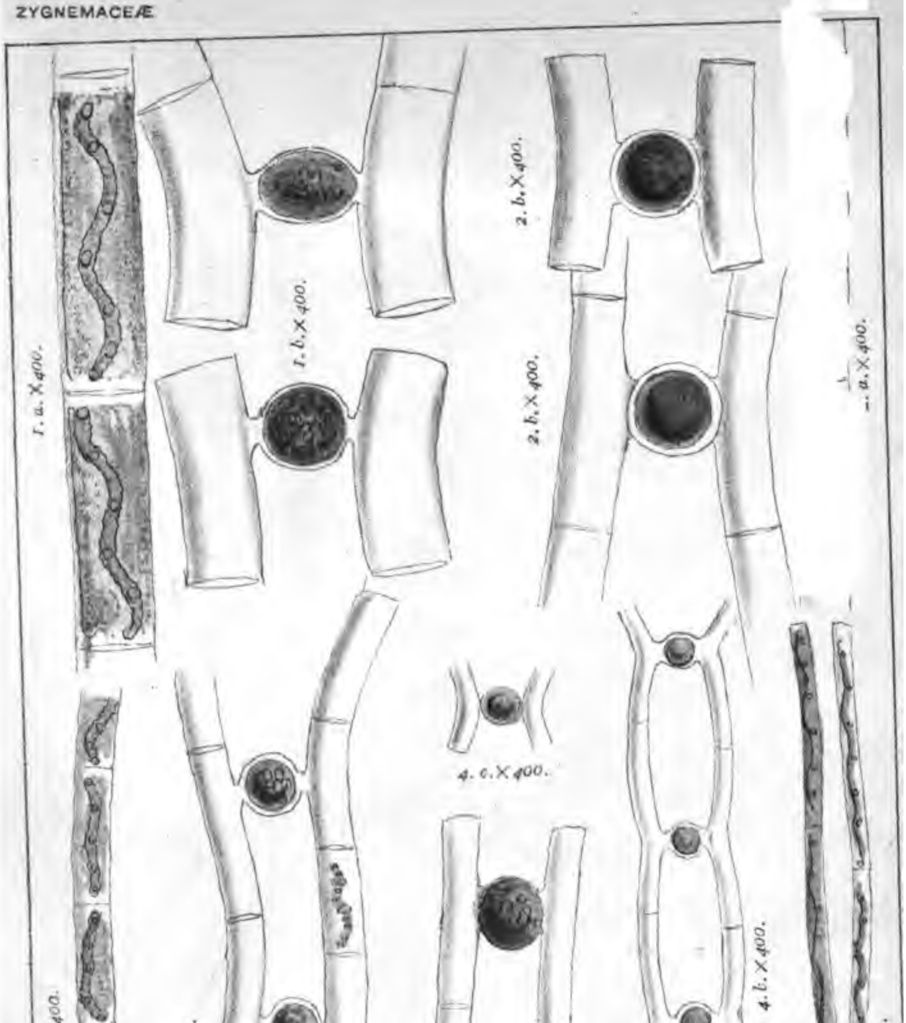
1. *Sirogonium sticticum. Kutz.* 2. Zygogonium ericetorum. De By.
3. *Z. ericetorum, var. aquaticum.* 4. Zygogonium gracile. Berk.



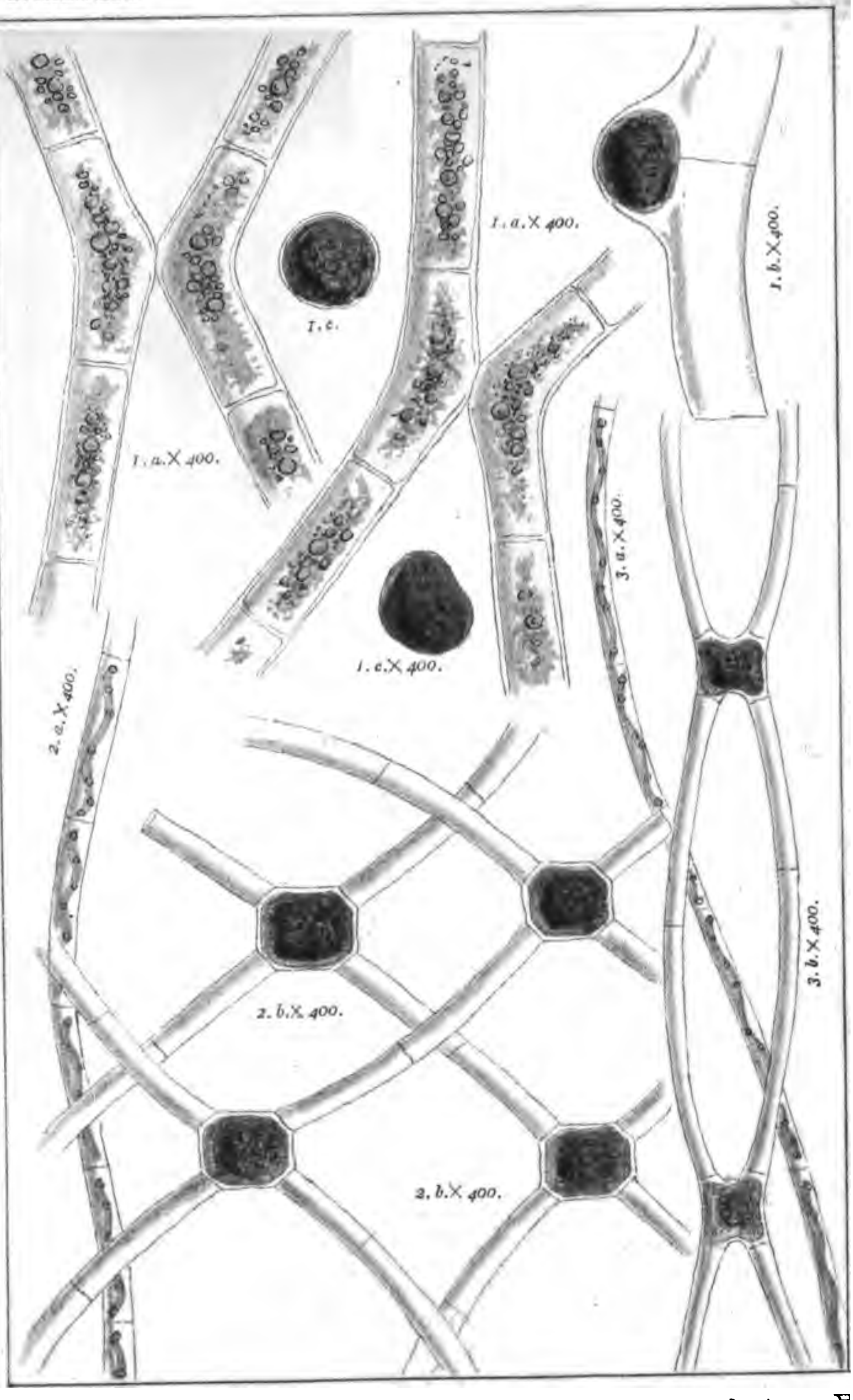
1. *Mougeotia glyptosperma.* DBy. 2. *Mougeotia lævis.* Archer.
3. *Mesocarpus nummuloides.* Hass. 4. Mesocarpus depressus. Hass
5. *Mesocarpus depressus. var. ovalis.*



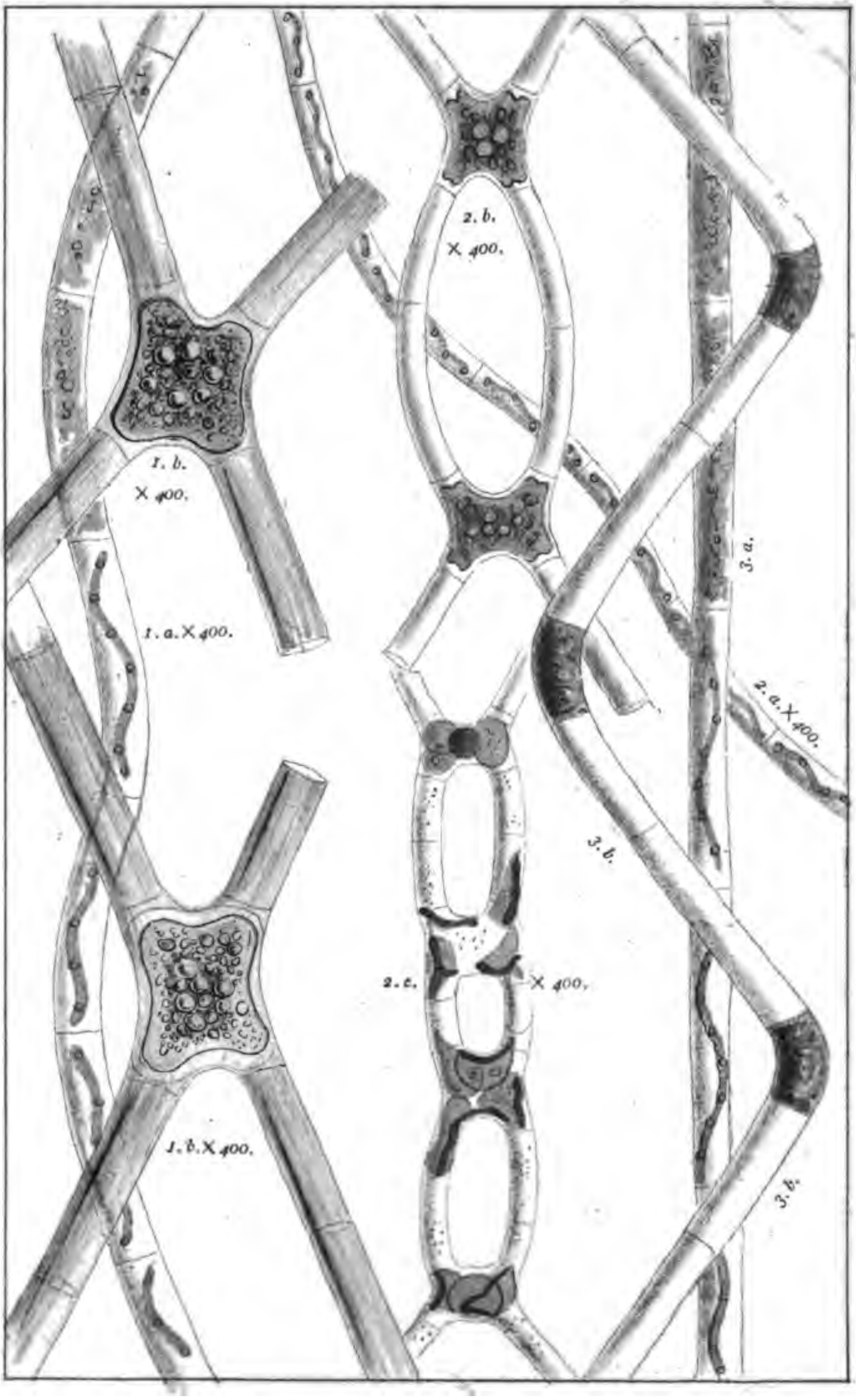
1-3 *Vaucheria terrestris. Lyngb.* 4. *Vaucheria racemosa. Haas.*
5.-6. *Vaucheria submarina. Berk.* 7. *Vaucheria velutina. Ag.*



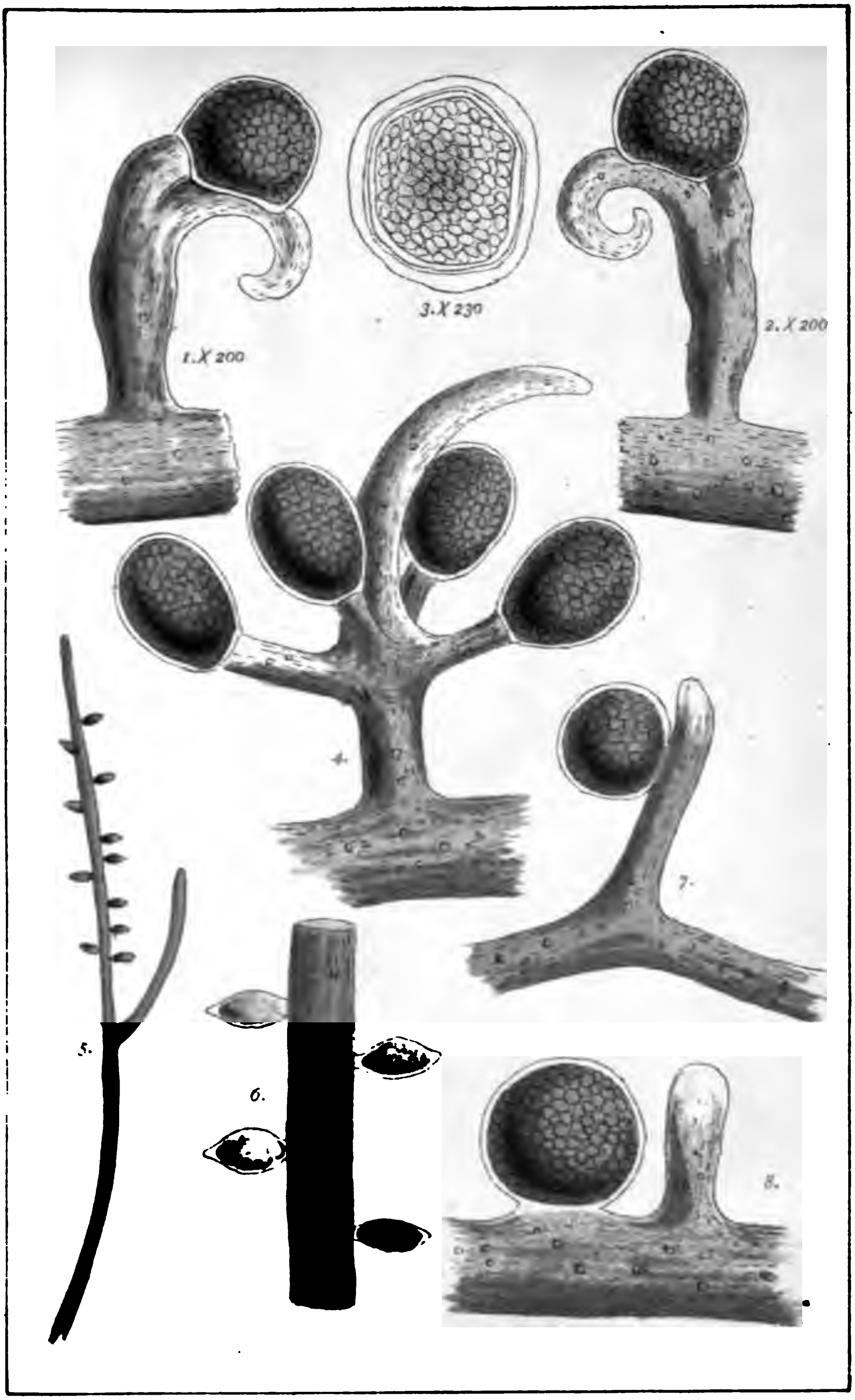
1. *Mesocarpus scalaris.* ...ss. 2. *Mesoc*... s recurvus. Hass.
3. *Mesocarpus parv*... 4. ... vulus, var. angustus. H...



1. *Mesocarpus pleurocarpus.* (D)By. 2. aurospermum quadratum. F
Staurospermum grc mum. Hass.

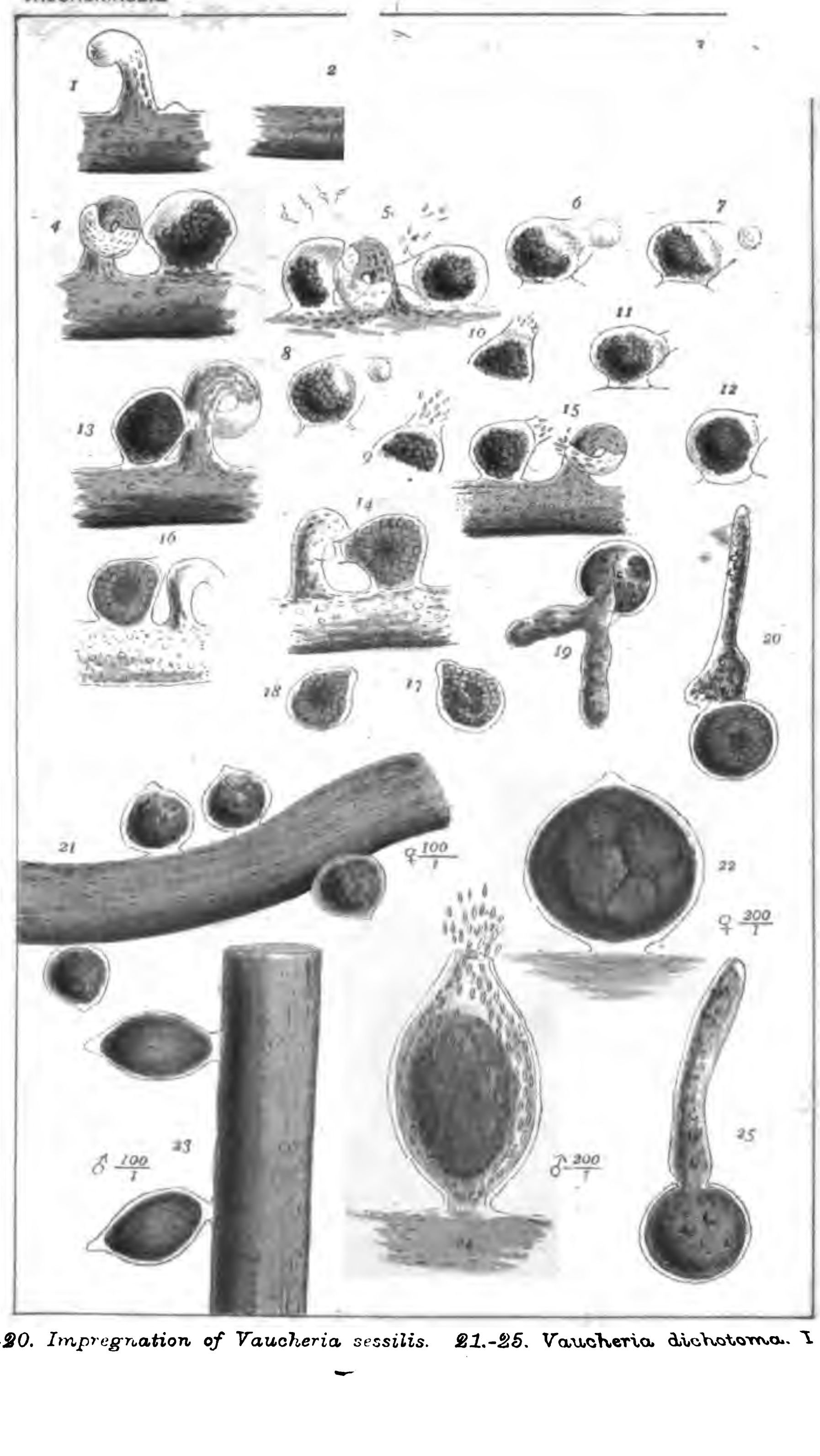


1. *Staurospermum capucinum*. Bory. 2. *Staurospermum viride*. Kutz
3. *Gonatonema mirabile*. Hass.

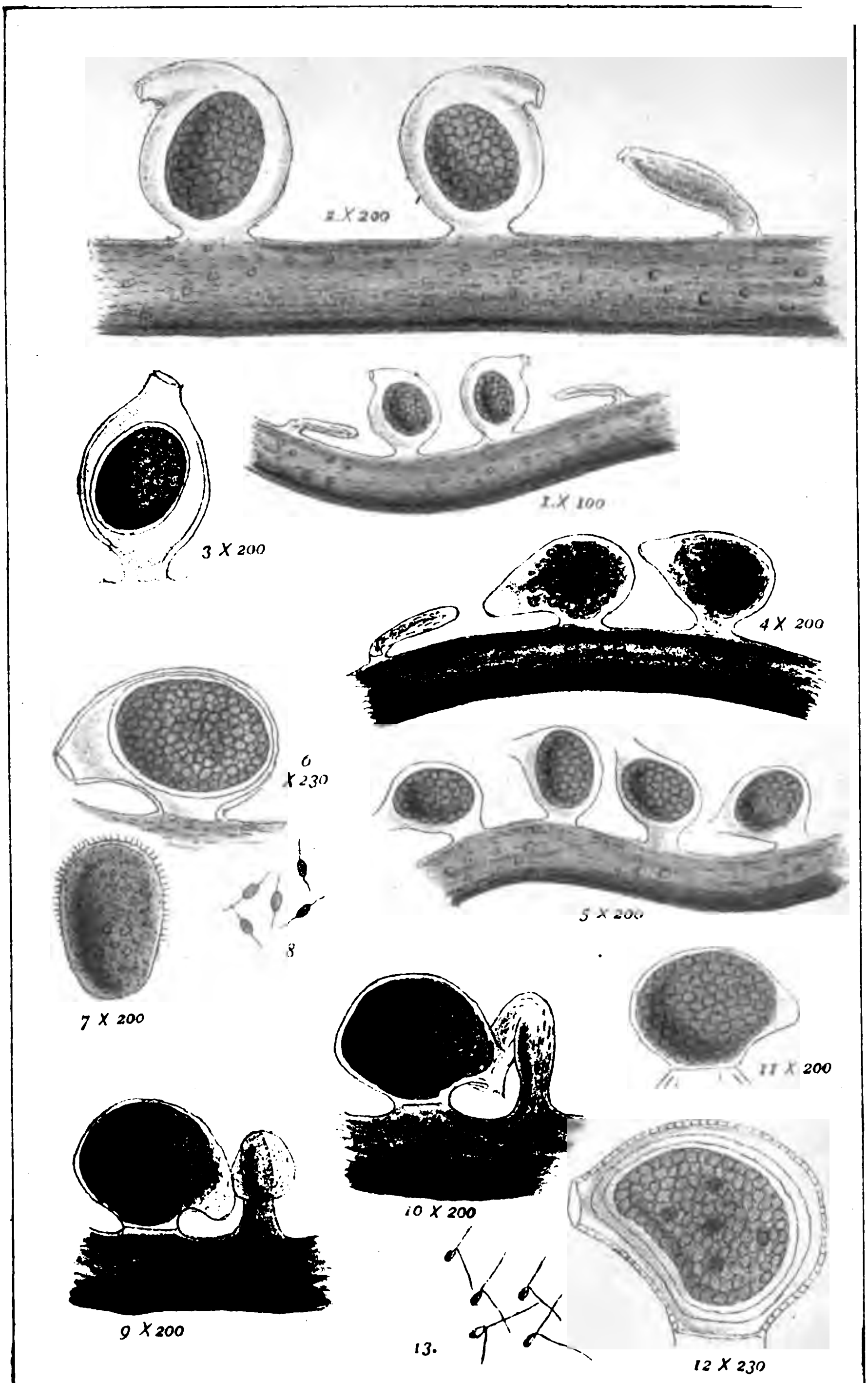


1-3 Vaucheria terrestris. Lyngb. 4. Vaucheria racemosa. Harv.

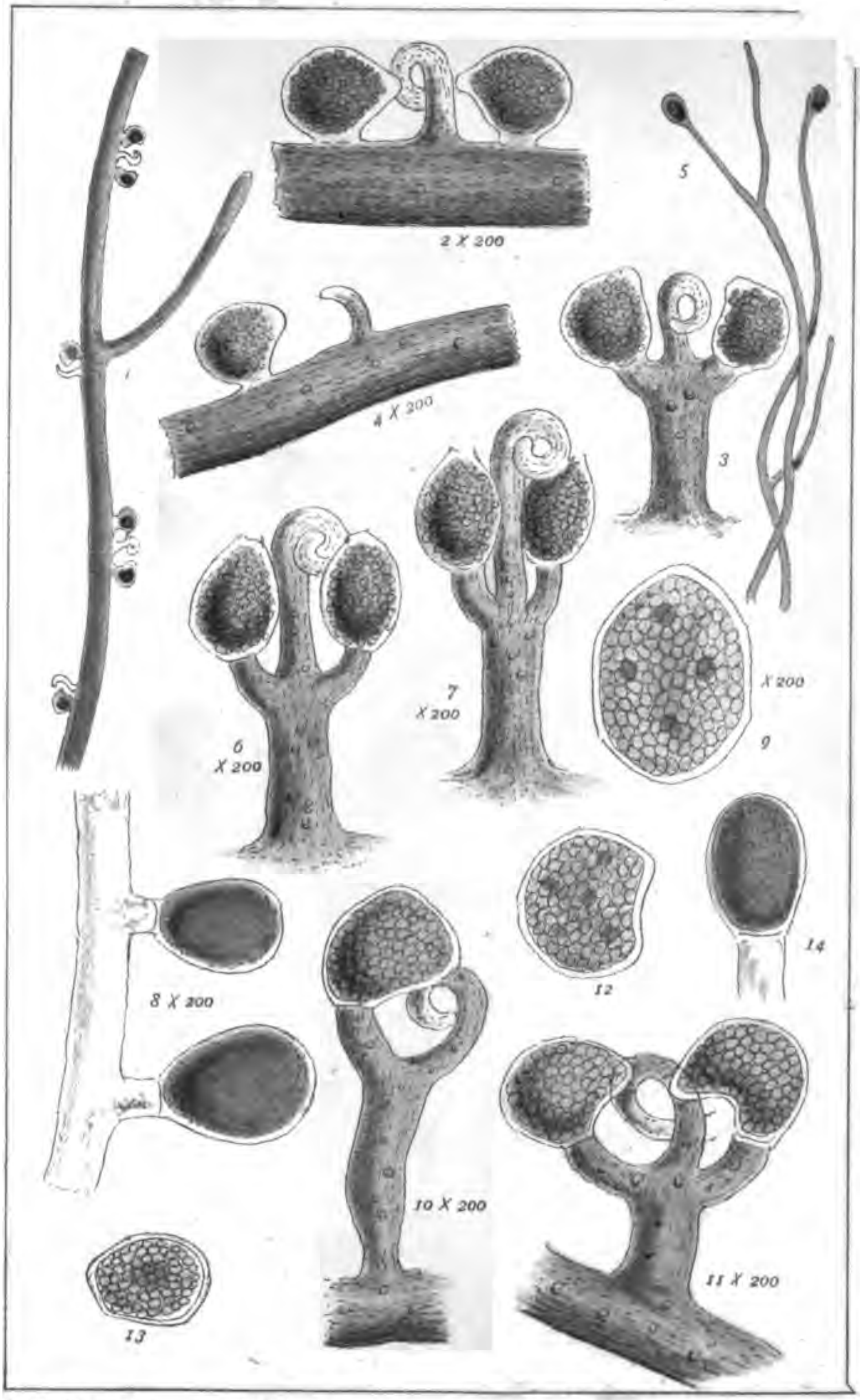
5-6. Vaucheria submarina. Berk. 7. Vaucheria velutina. Ag.



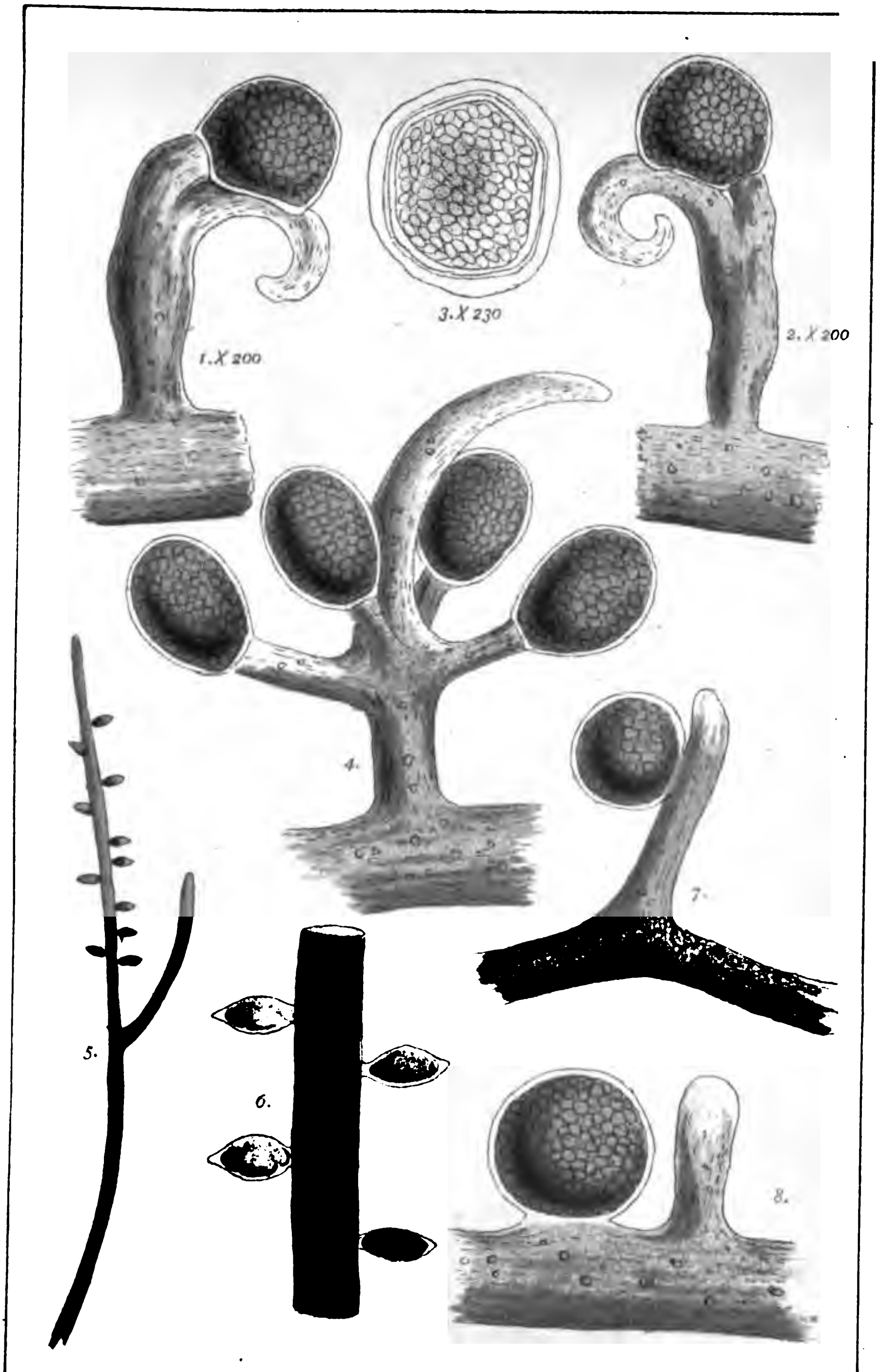
1.-20. *Impregnation of Vaucheria sessilis.* 21.-25. Vaucheria dichotoma. I



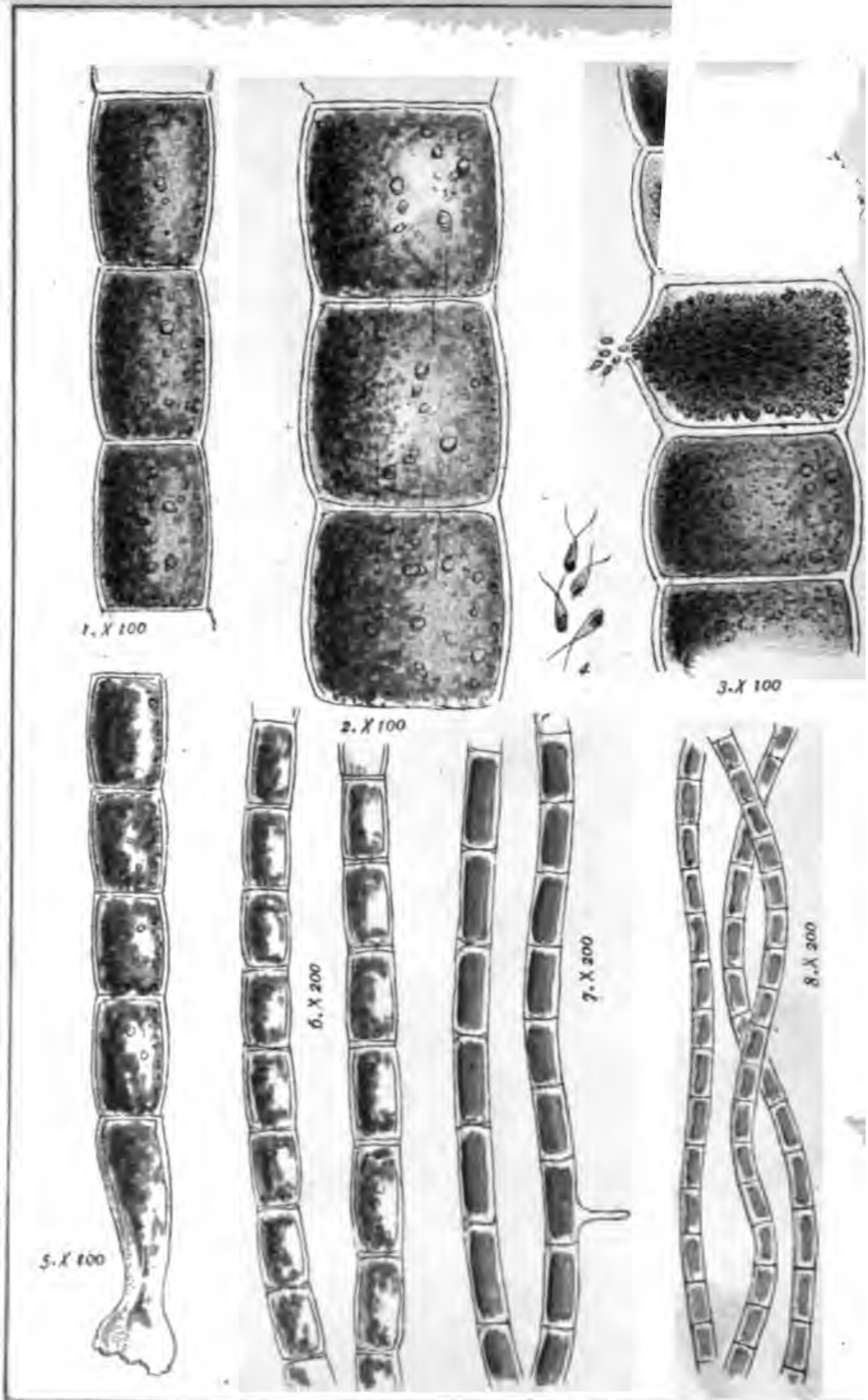
1-3 *Vaucheria aversa. Hass.* 4.-8. *Vaucheria sericea. Lyngb.*
9.-13. *Vaucheria Dillwynii. Ag.*



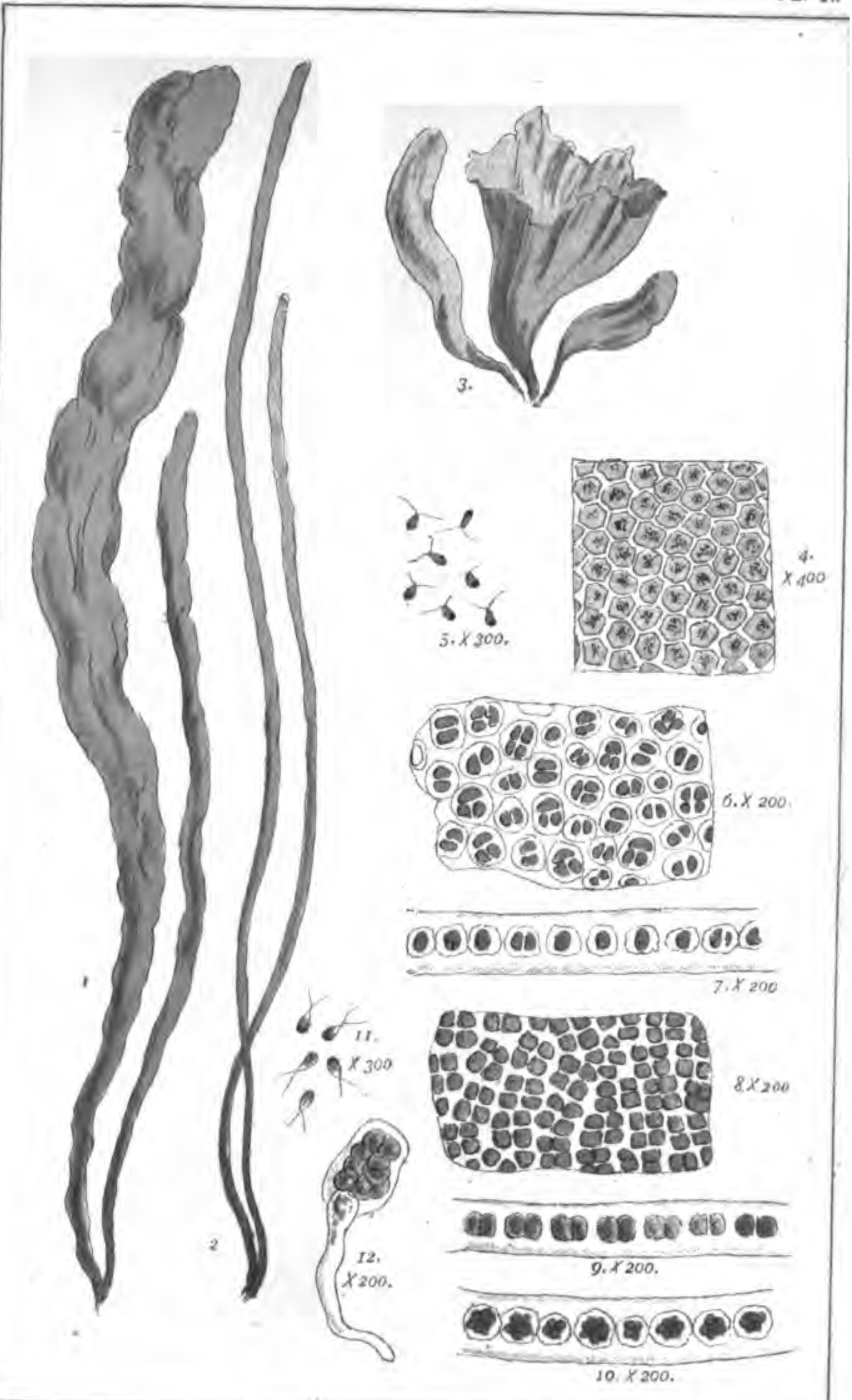
1.-2. Vaucher : lis. V :h. 3. c 4. repens. 5. sporangi
6.-9. Vauche . C. Vaucheria hamata. I



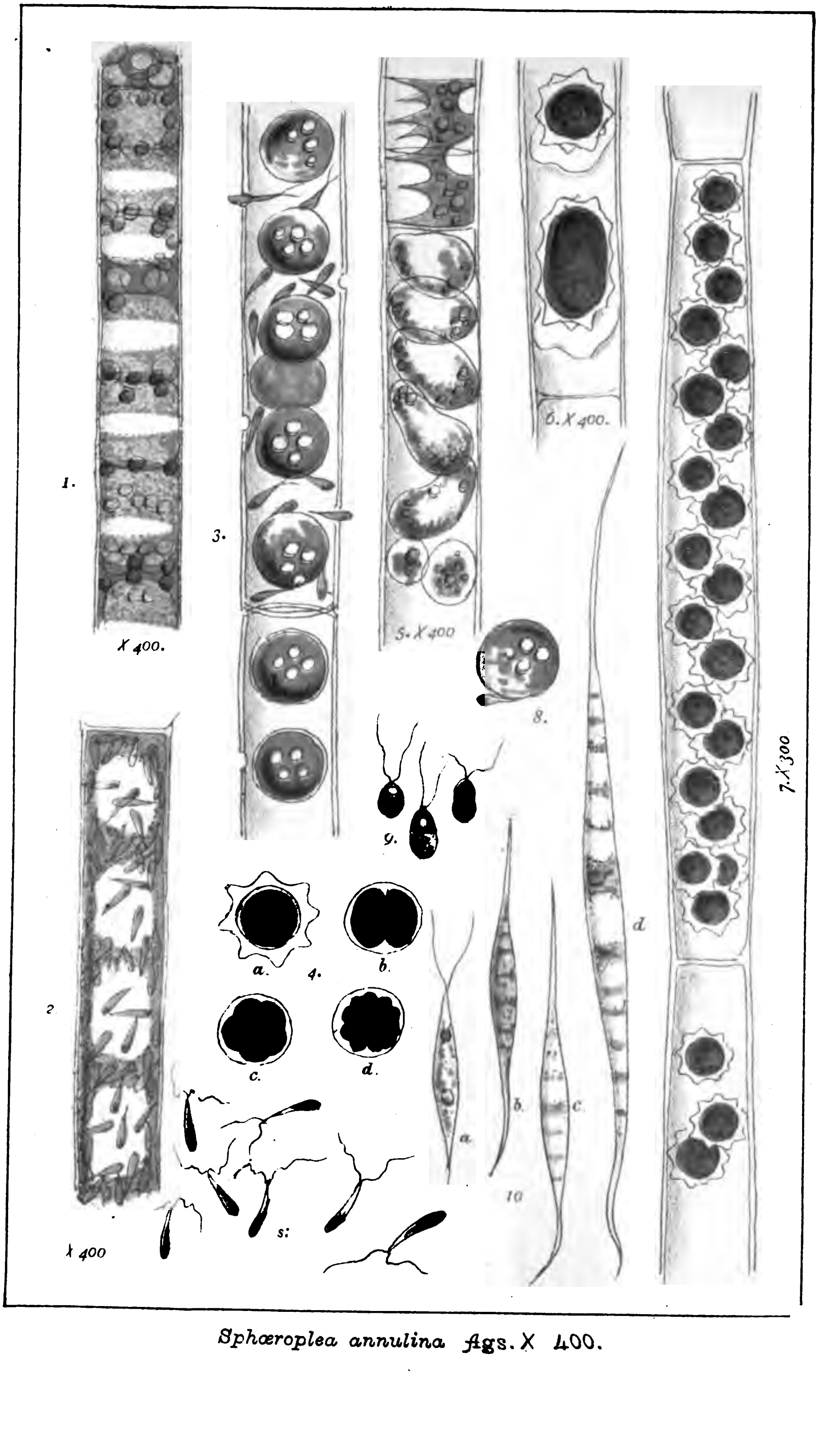
1.-3 *Vaucheria terrestris. Lyngb.* 4. Vaucheria racemosa. Hass.
5.-6. *Vauch a . bmarina. Berk.* 7. Vaucheria velutina. Ag.



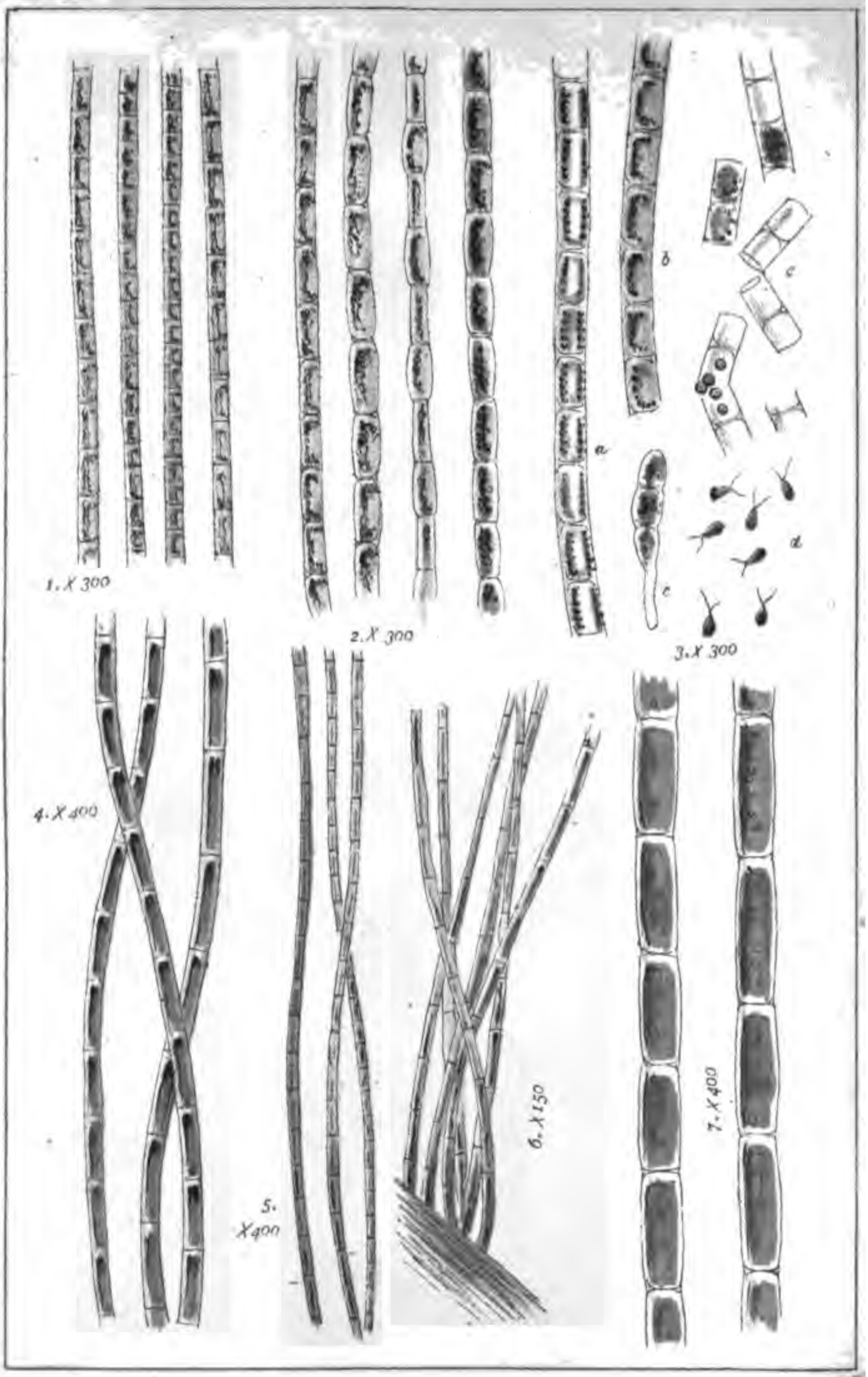
1. *Chætomorpha litorea. Harv.* 2.-4. *Chætomorpha linum. K.*
5. *Chætomorpha sutoria. Berk.* 6. *Chætomorpha implexa. Dillw.*
7. *Rhizoclonium Casparyi. Harv.* 8. *Rhizoclonium flavicans. J.*



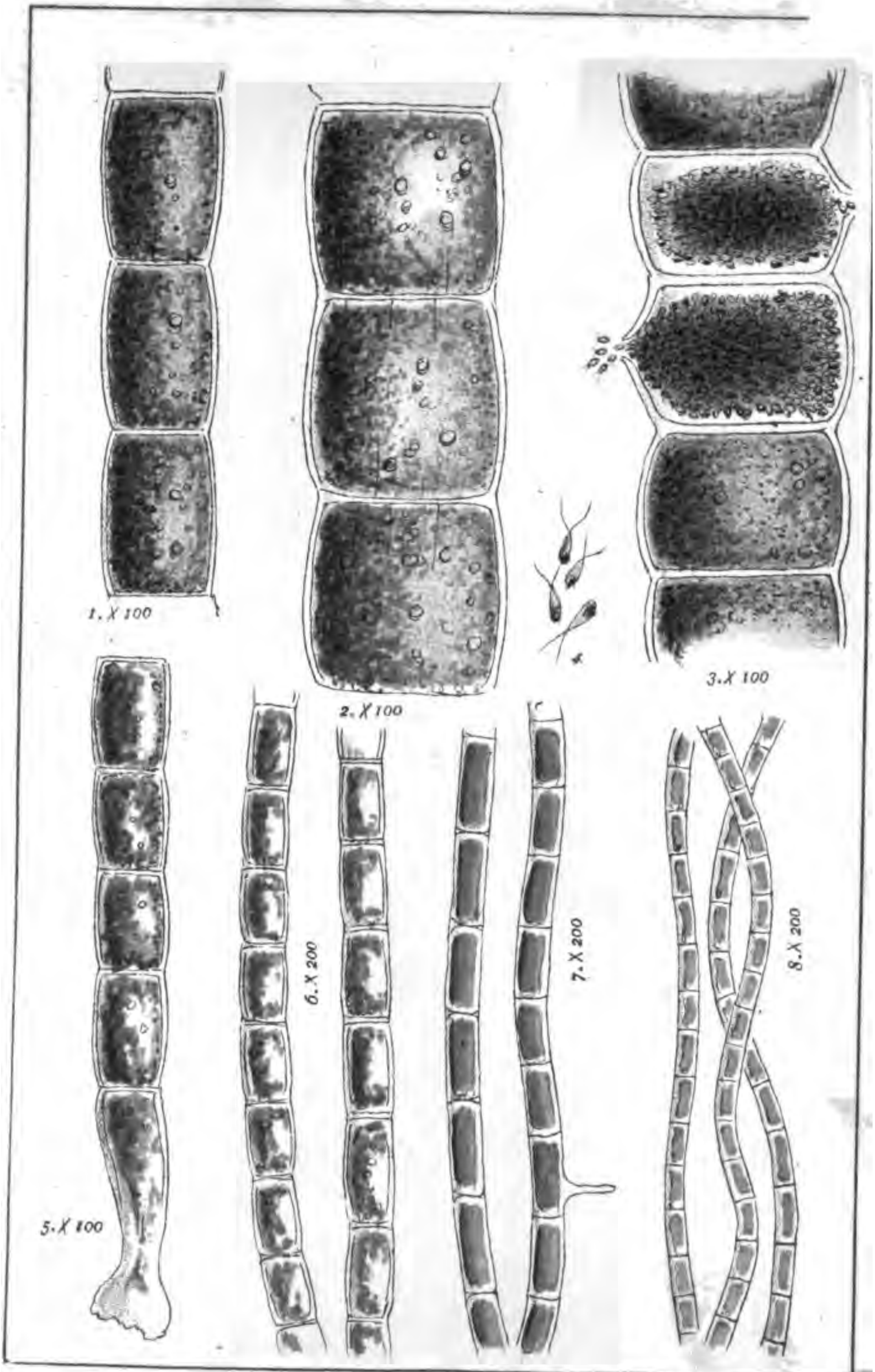
1.-5. *Enteromorpha intestinalis. L.* 6.-7. *Monostroma laceratum. Thur*
8.-12. *Monostroma Wittrockii. Born.*



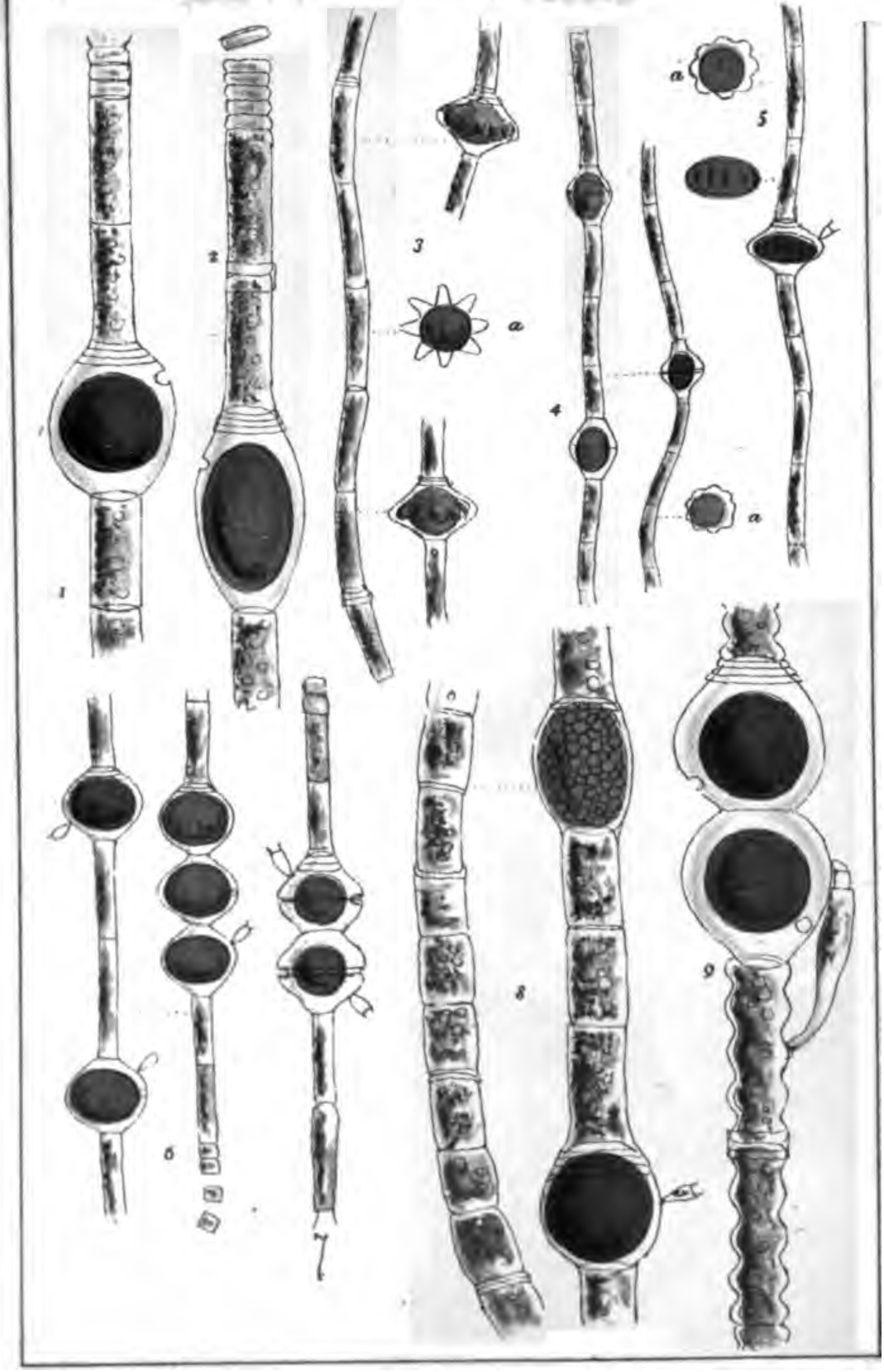
Sphœroplea annulina figs. X 400.



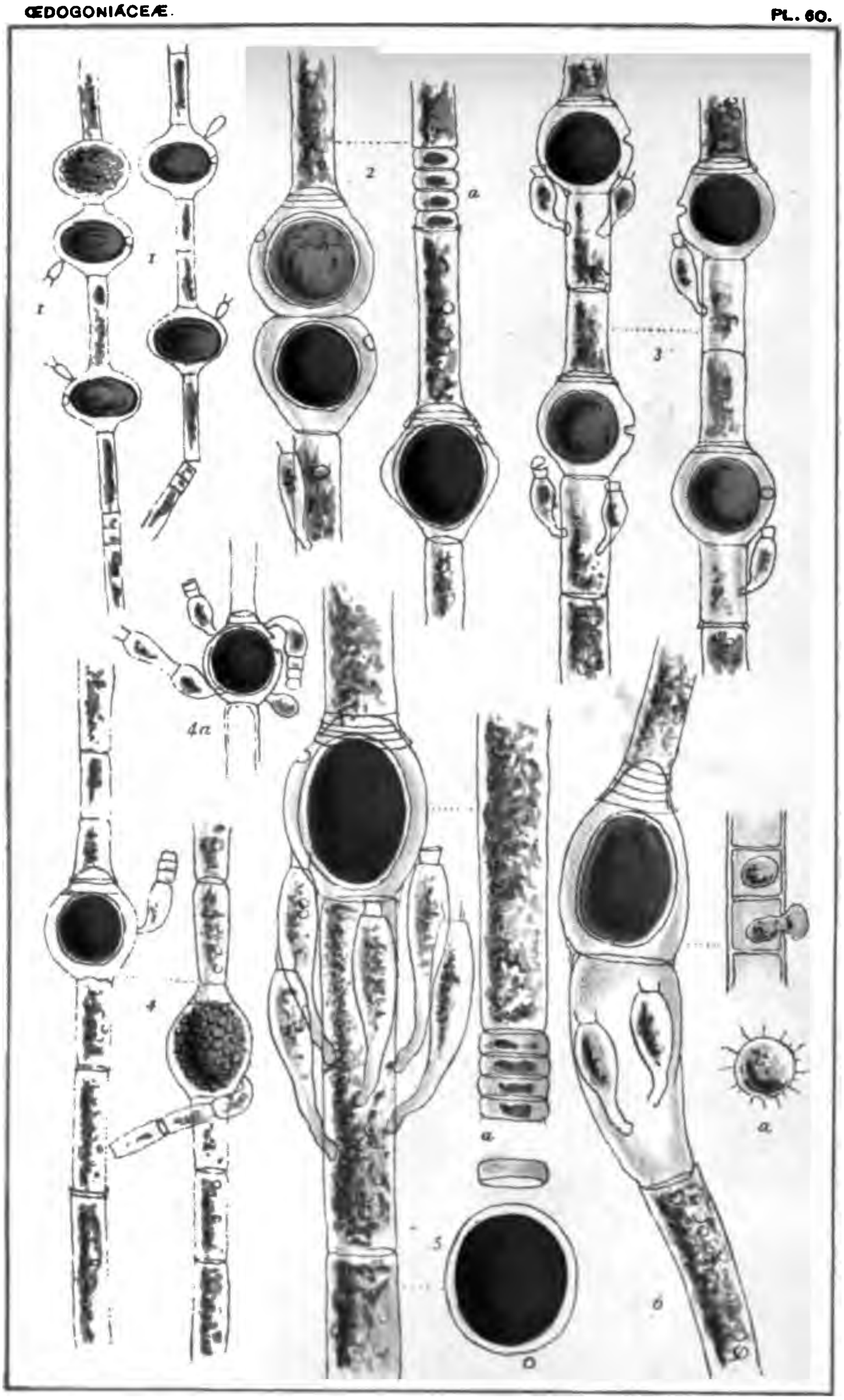
1. *Microspora fugacissima.* Thur. 2. *Microspora vulgaris.* Rabh.
3. *Microspora floccosa.* Thur. 4. *Conferva bombycina.* Ag
5. *Conferva tenerrima.* Kutz. 6.-7. *Conferva fontinalis.* Berk.



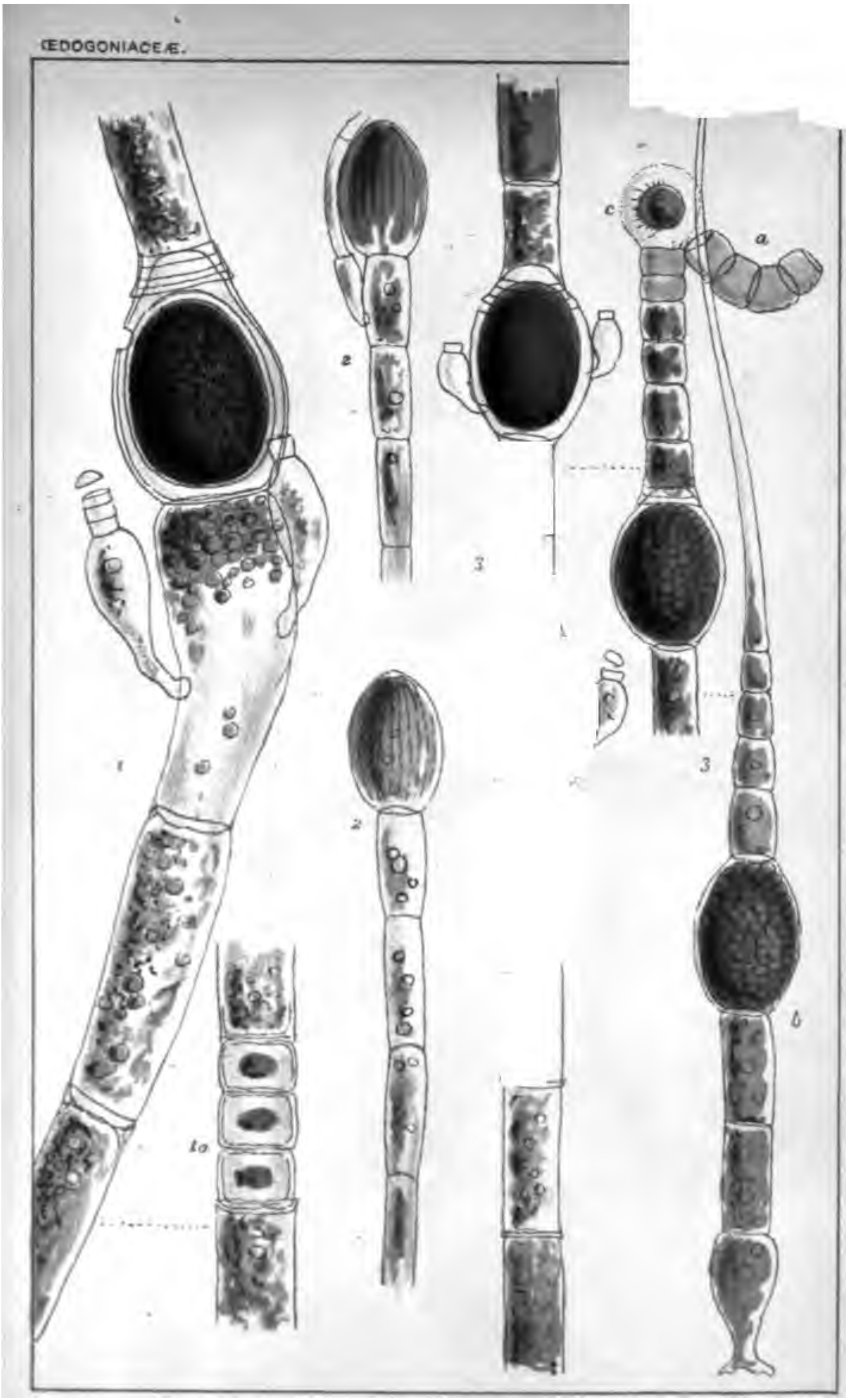
1. *Chætomorpha* rea. H , 2.-4. *Chætomorpha linum.* K.
5. *Chætomor* ,, 6. Ch morpha implexa. C
7. *Rhizooloni* lonium flavicans. J



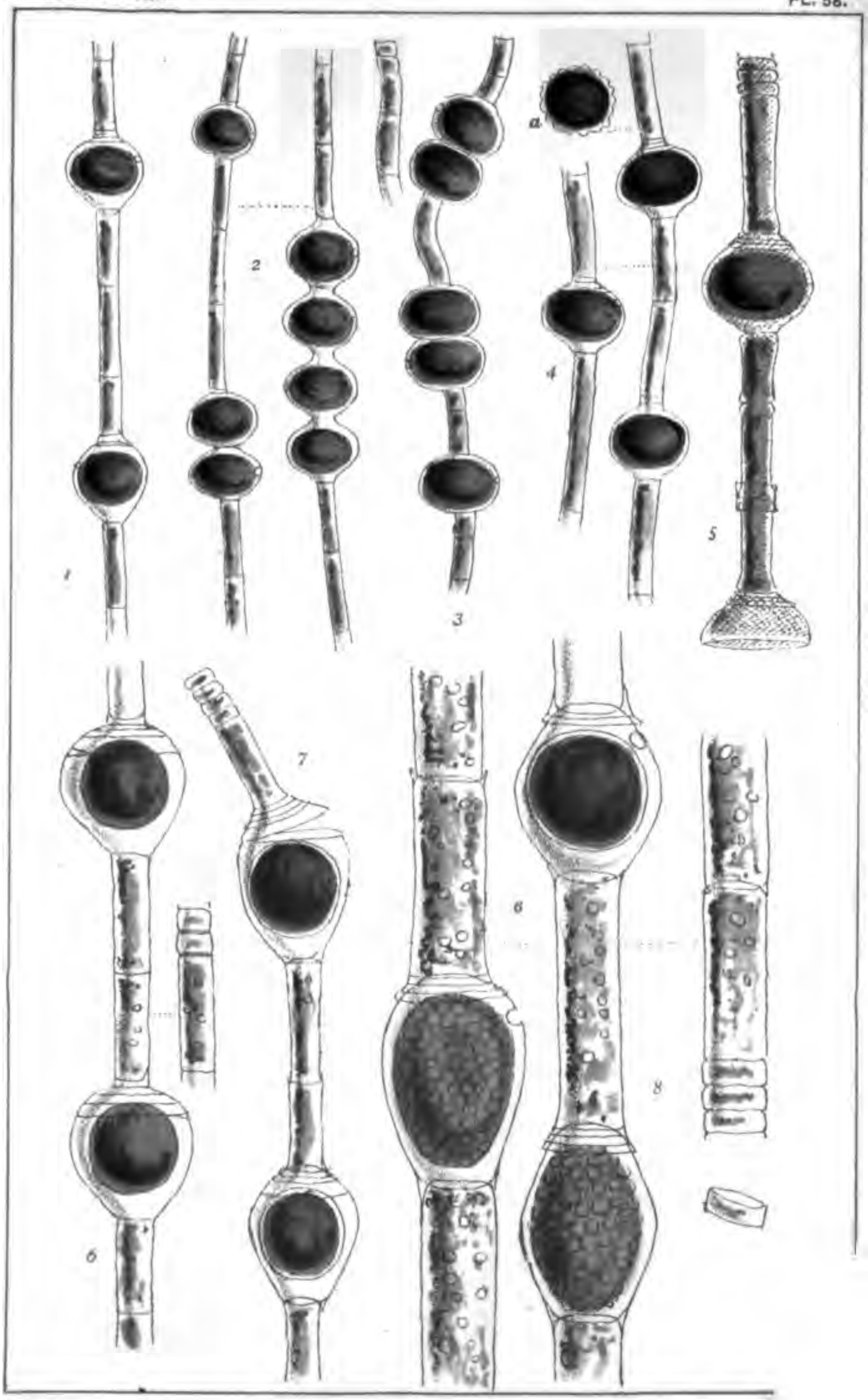
1. Œdog. urbicum W. 2. Œdog. paludosum. Hass. 3. Œdog. Itzigsohnii.
4. Œdog. excisum. W. 5. Œdog. platygynum. W. 6. Œdog. Rothii.
7. Œdog. Areschougii. W. 8. Œdog. pluviale. Nord. 9. Œdog. undulatum



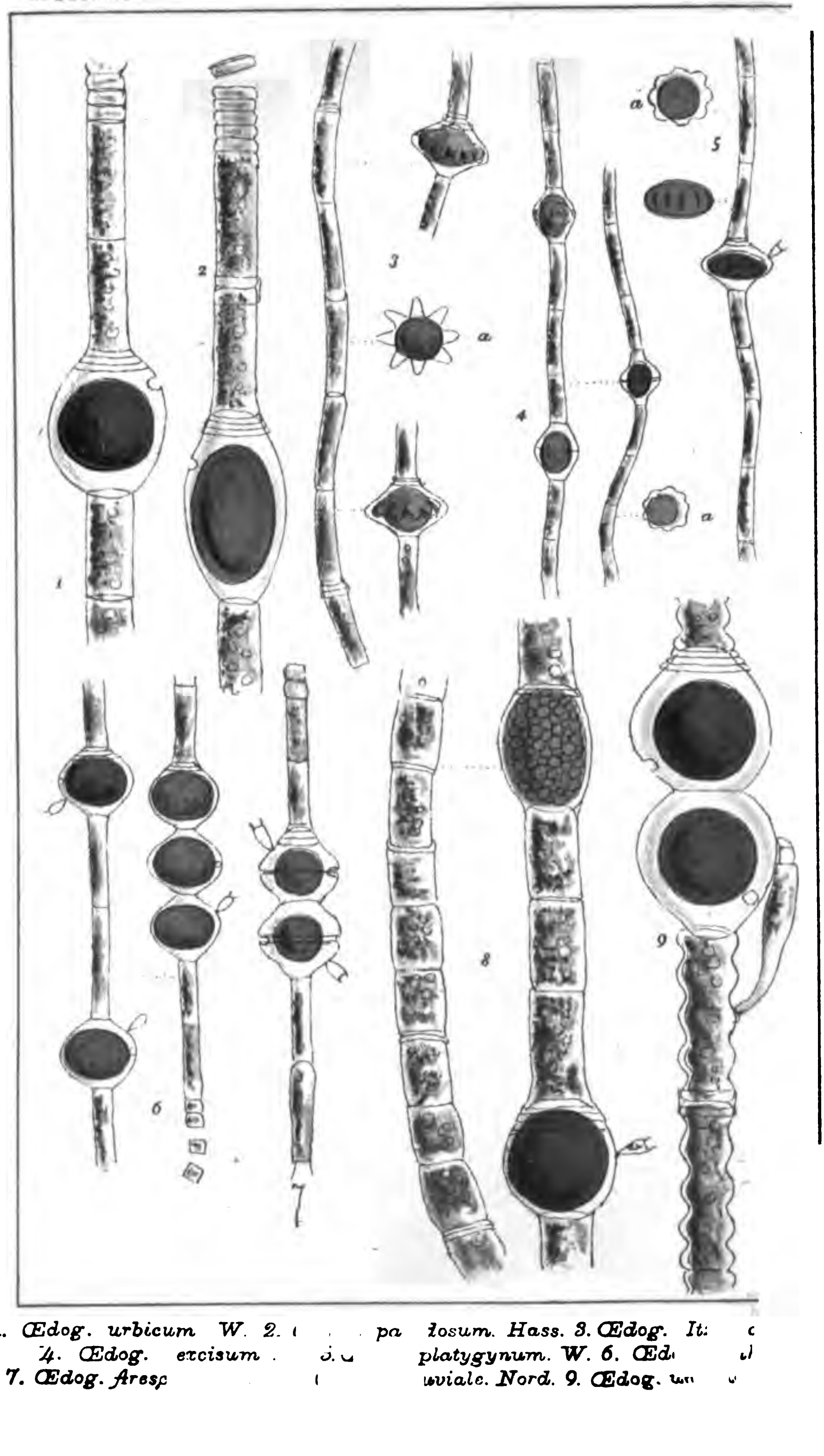
1 Œdog. depressum W. 2 Œdog. flavescens Hass. 3 Œdog. Braunii Kütz.
4. Œdog. macrandrum W. 5. Œdog. crassiusculum W. 6 Œdog. Borisianum



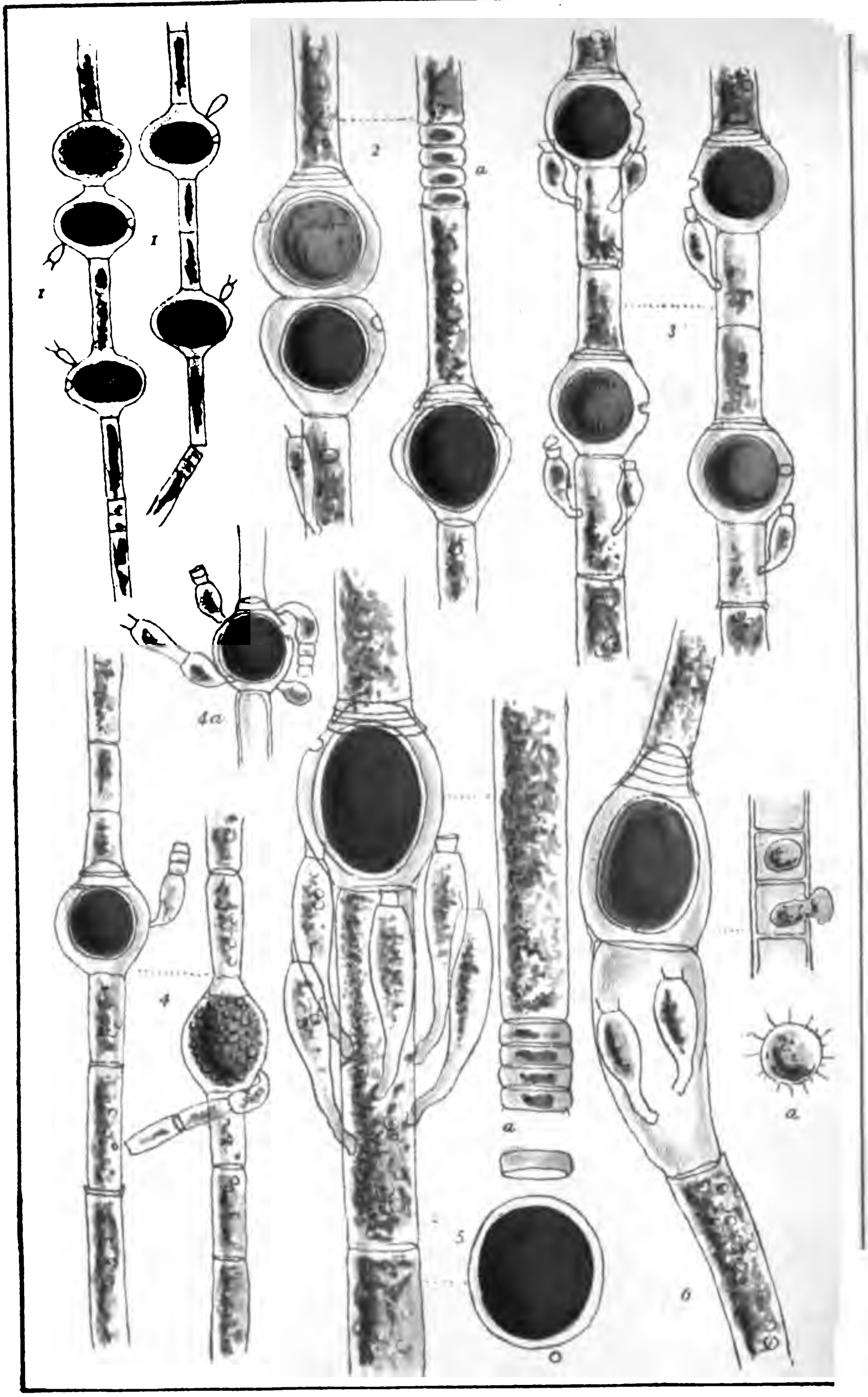
Œdog. concatenatum. Hass. 2 Œdog. acrosporum. D.By. 3. Œdog. ciliatum.



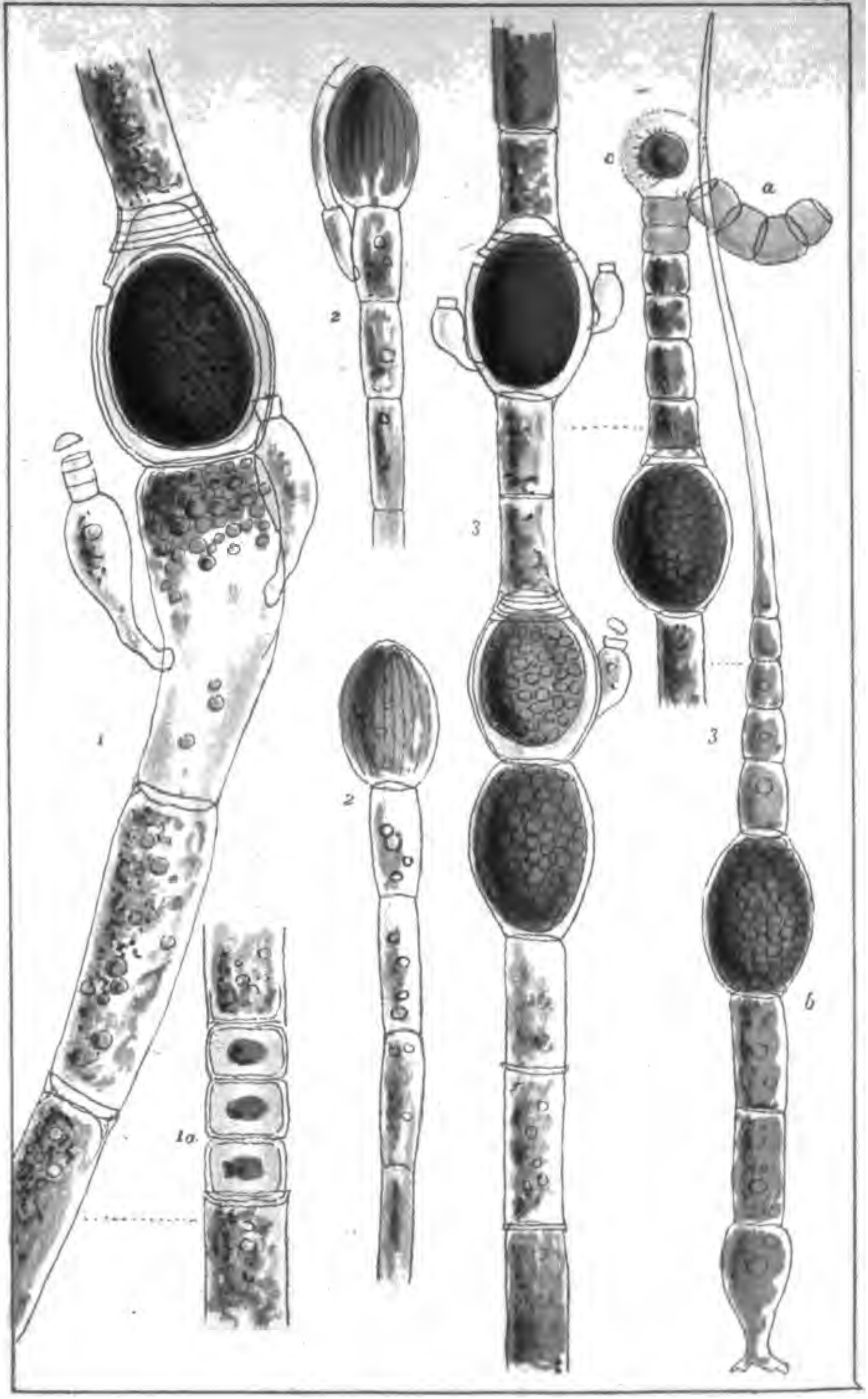
1. Œdogonium Petri. W. 2 Œdog. cryptoporum. W. 3 Œdog. curvum
4. Œdog. cymatosporum. W. 5. Œdog. minus. W. 6. Œdog. vernale. K
7. Œdog. crispum. Hass. 8. Œd. Vaucherii. Br.



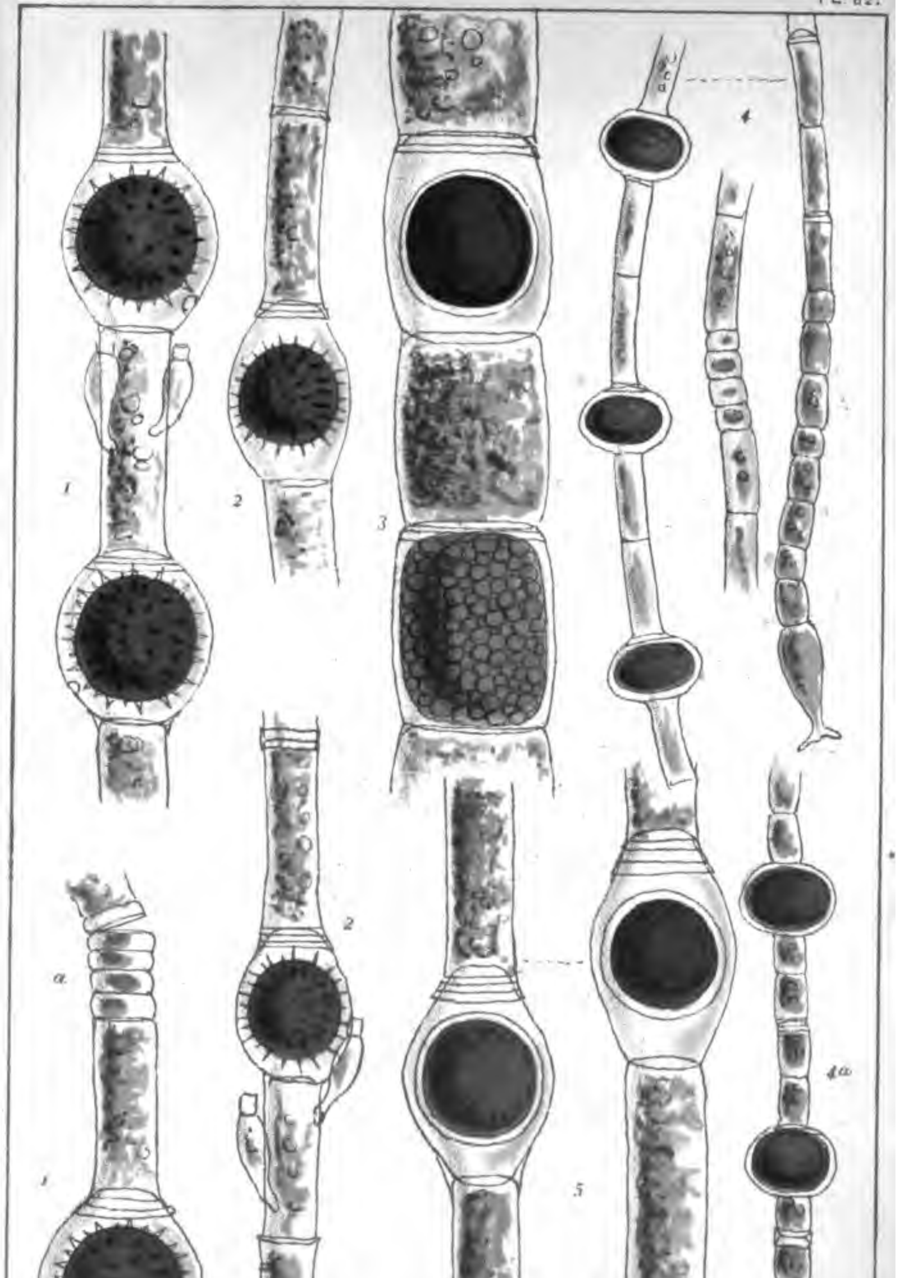
1. *Œdog. urbicum* W. 2. ... *pa ... losum.* Hass. 3. *Œdog.* It... c
4. *Œdog. excisum* . 5. ... *platygynum.* W. 6. *Œd...* ...
7. *Œdog. Aresp...* ... *...uviale.* Nord. 9. *Œdog.* ...



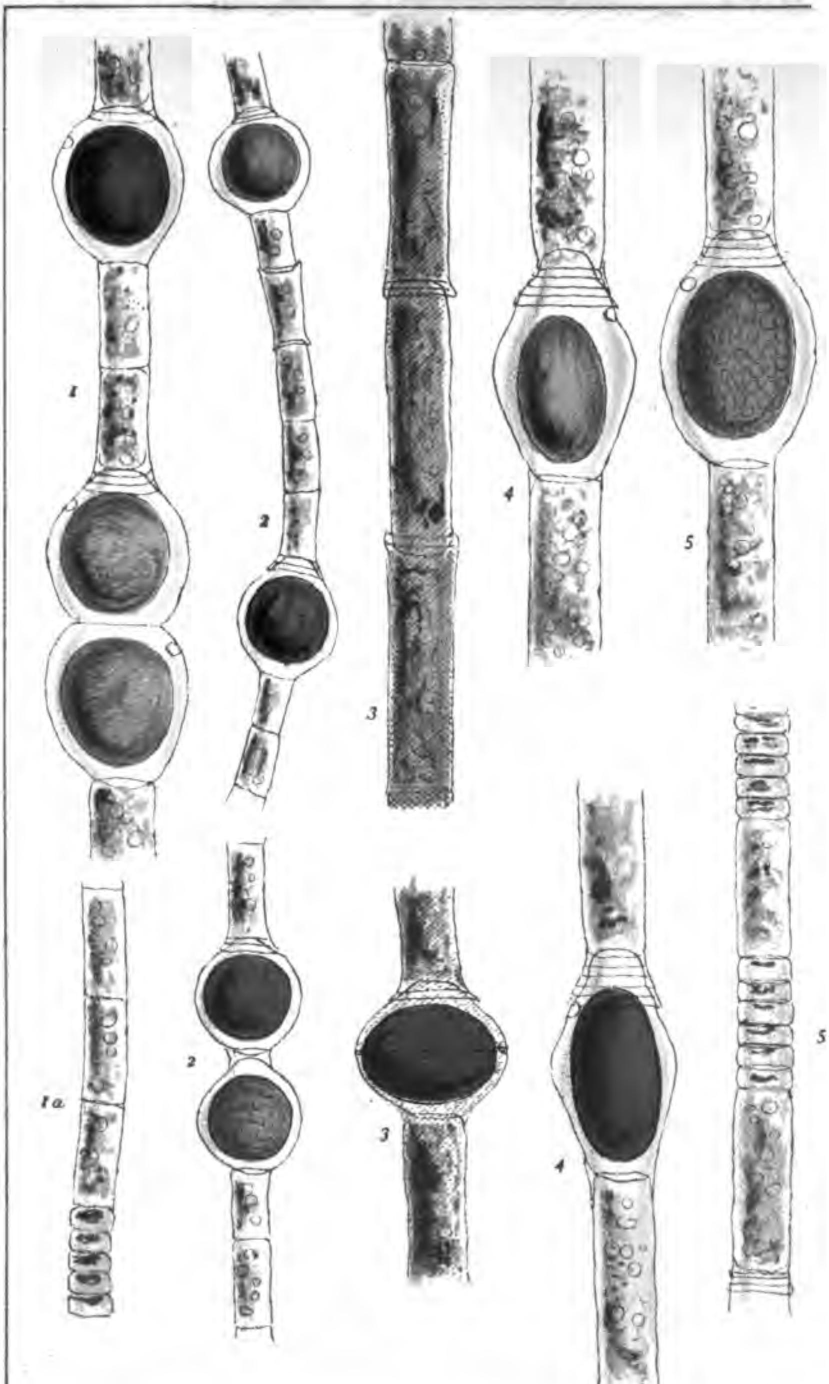
1. Œdog. depressum. Pr. 2. Œdog. flavescens. Hass. 3 Œdog. Braunii
4. Œdog. macrandum. W. 5. Œdog. crassiusculum. W. 6. Œdog. Bc



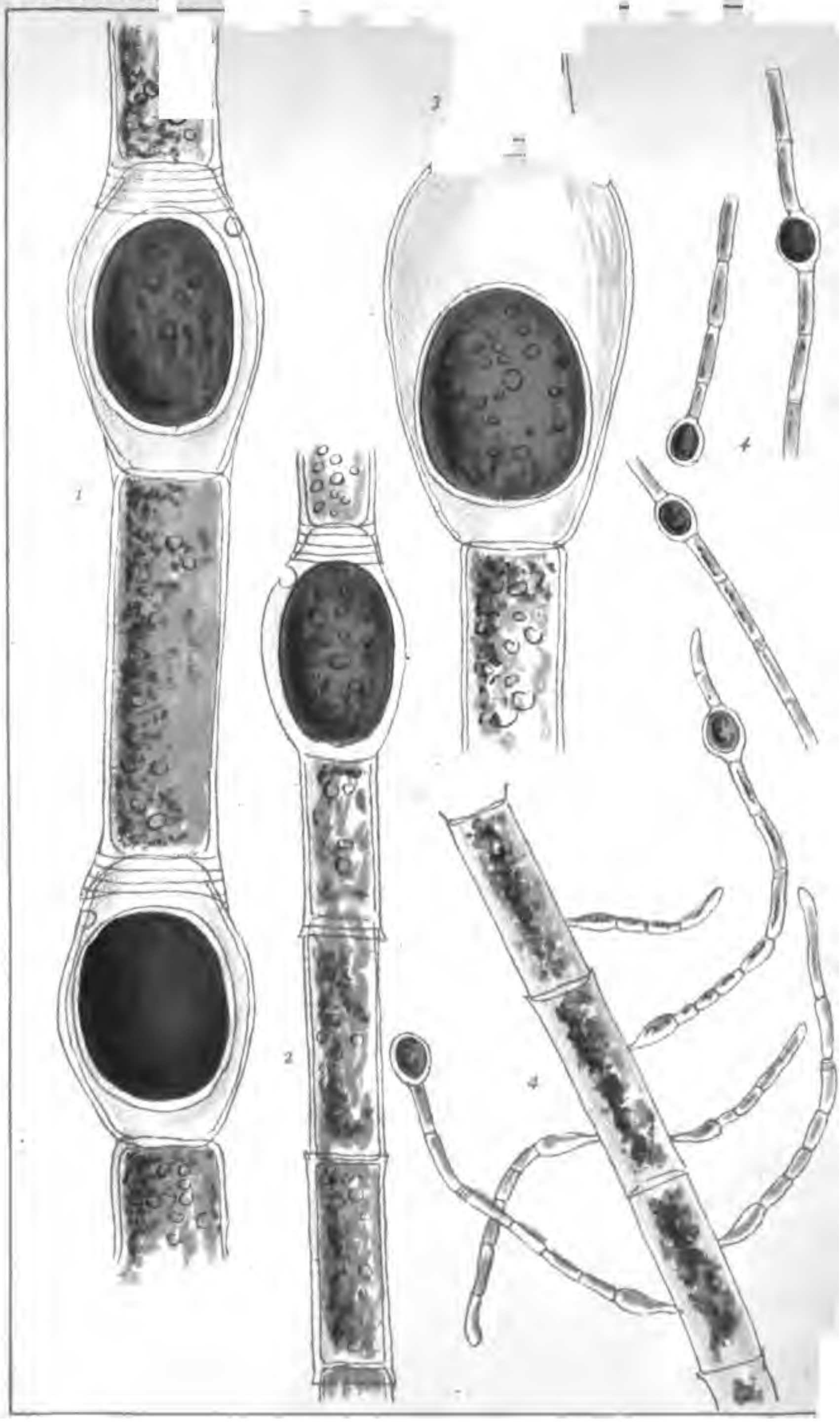
1. Œdog. concatenatum. Hass. 2 Œdog. acrosporum. D.By. 3. Œdog. ciliatu



1. Œdog. Cleveanum W. 2 Œdog. echinospermum. Br. 3. Œdog. capillare (
4. Œdog. calcareum. W. 5 Œdog. cardiacum. Hass.

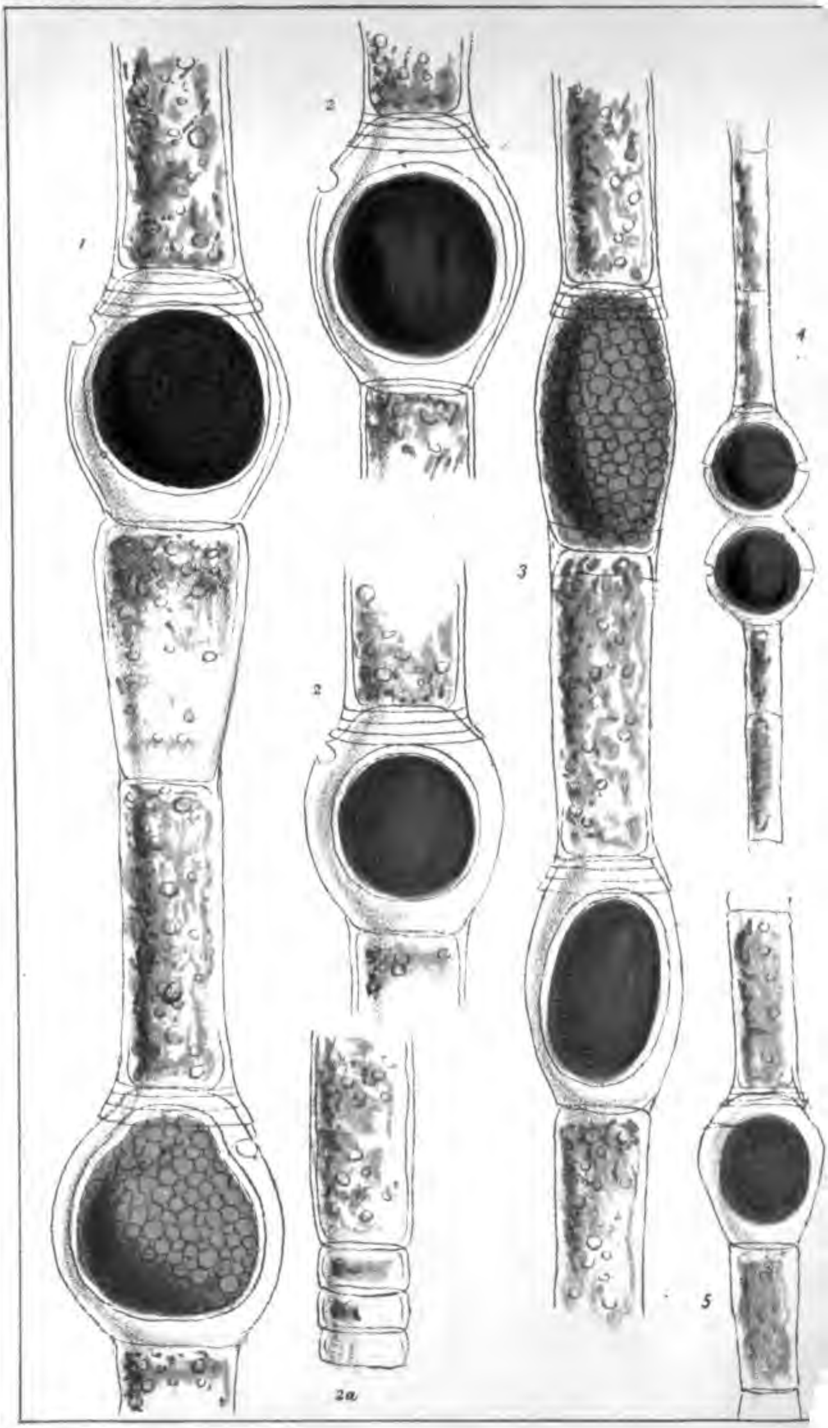


1. *Œdog. carbonicum. W.* 2. *Œdog. Pringsheimii .W.* 3. *Œdog. pun*
striatum. DBy. 4 *Œdog. Boscii .W.* 5. *Œdog. tumidulum. Ku*

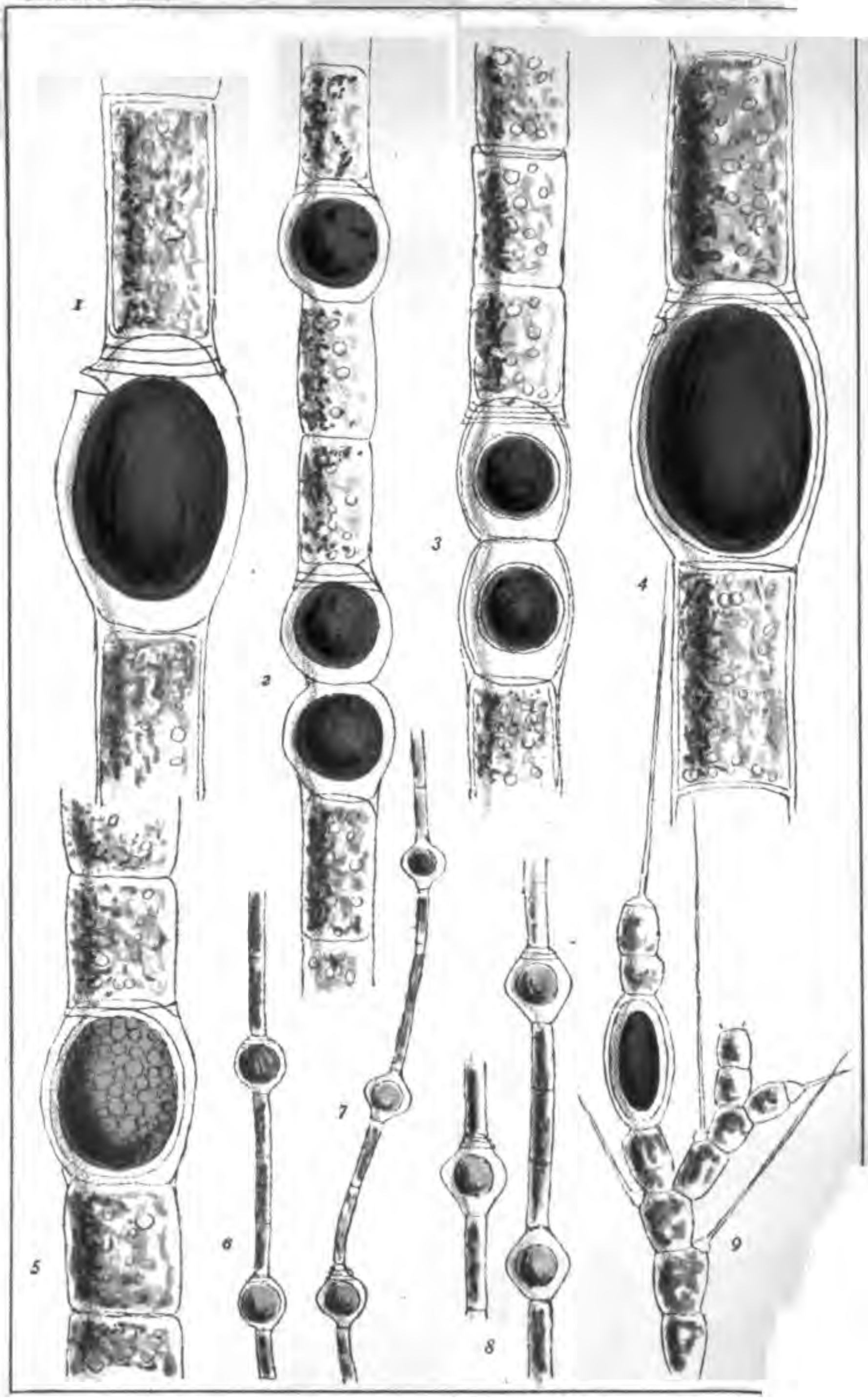


1. *Œdog. Landsboroughii. Hass.* 2. *variety* gemelliparum. Pr.
3. *Œdog. rivulare. Br.* 4 Œdog. longatum Kutz.

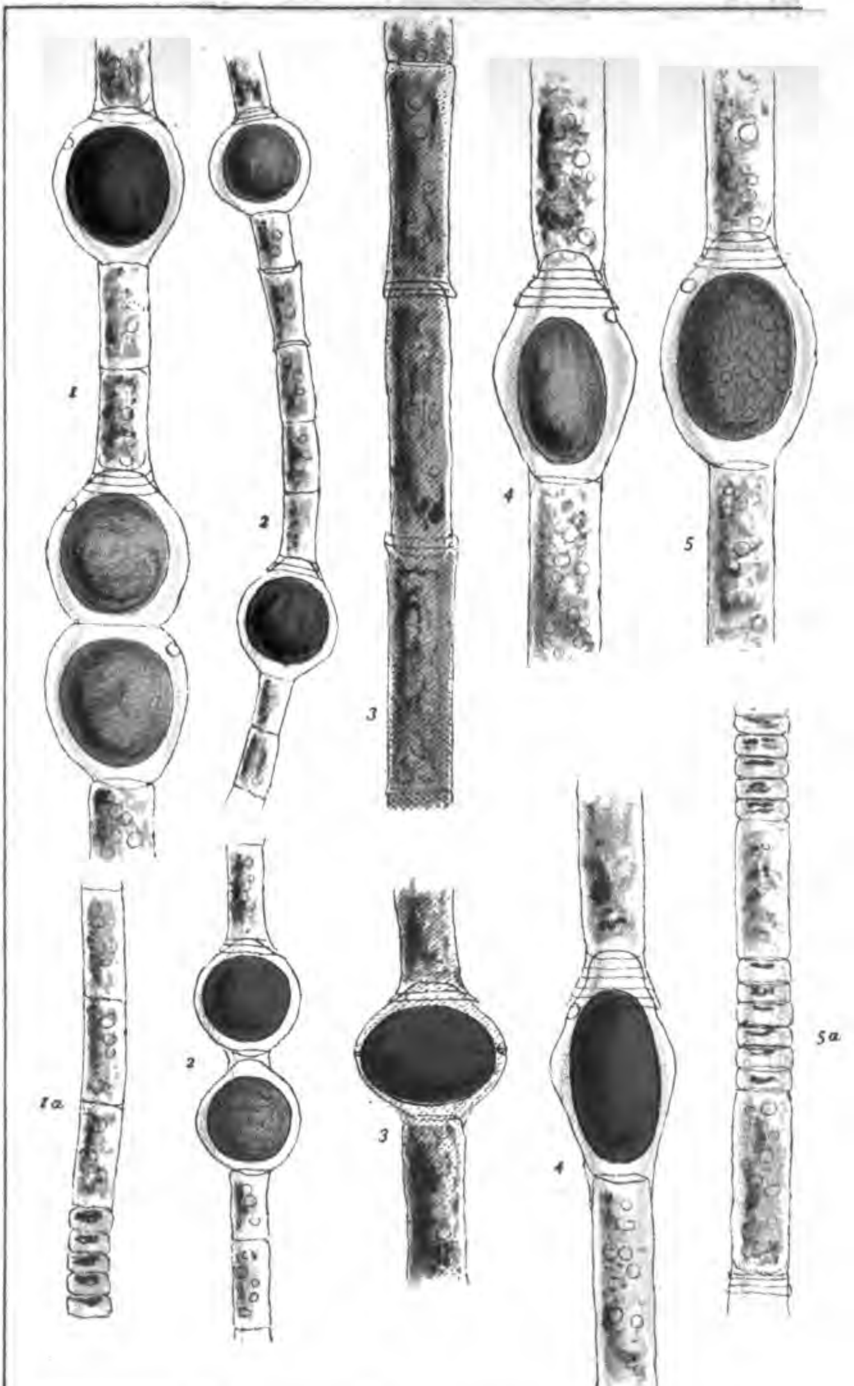
ŒDOGONIACEÆ.



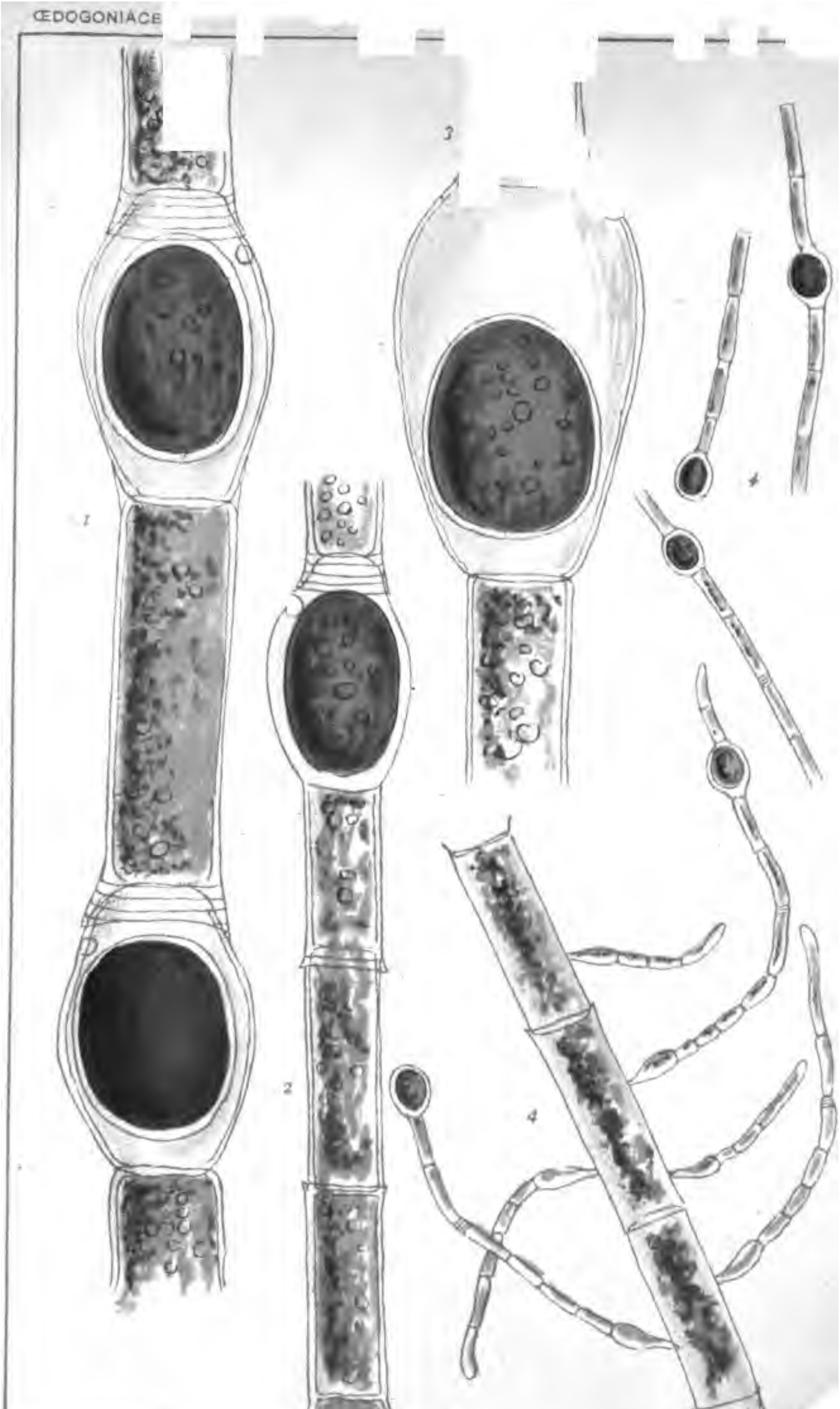
1. *Œdog. Hutchinsiæ W.* 2. *Œdog. princeps Hass.* 3. Œdog. gigante
4. *Œdog: Londinense. W.* 5. Œdog. vesicatum. Lyngb.



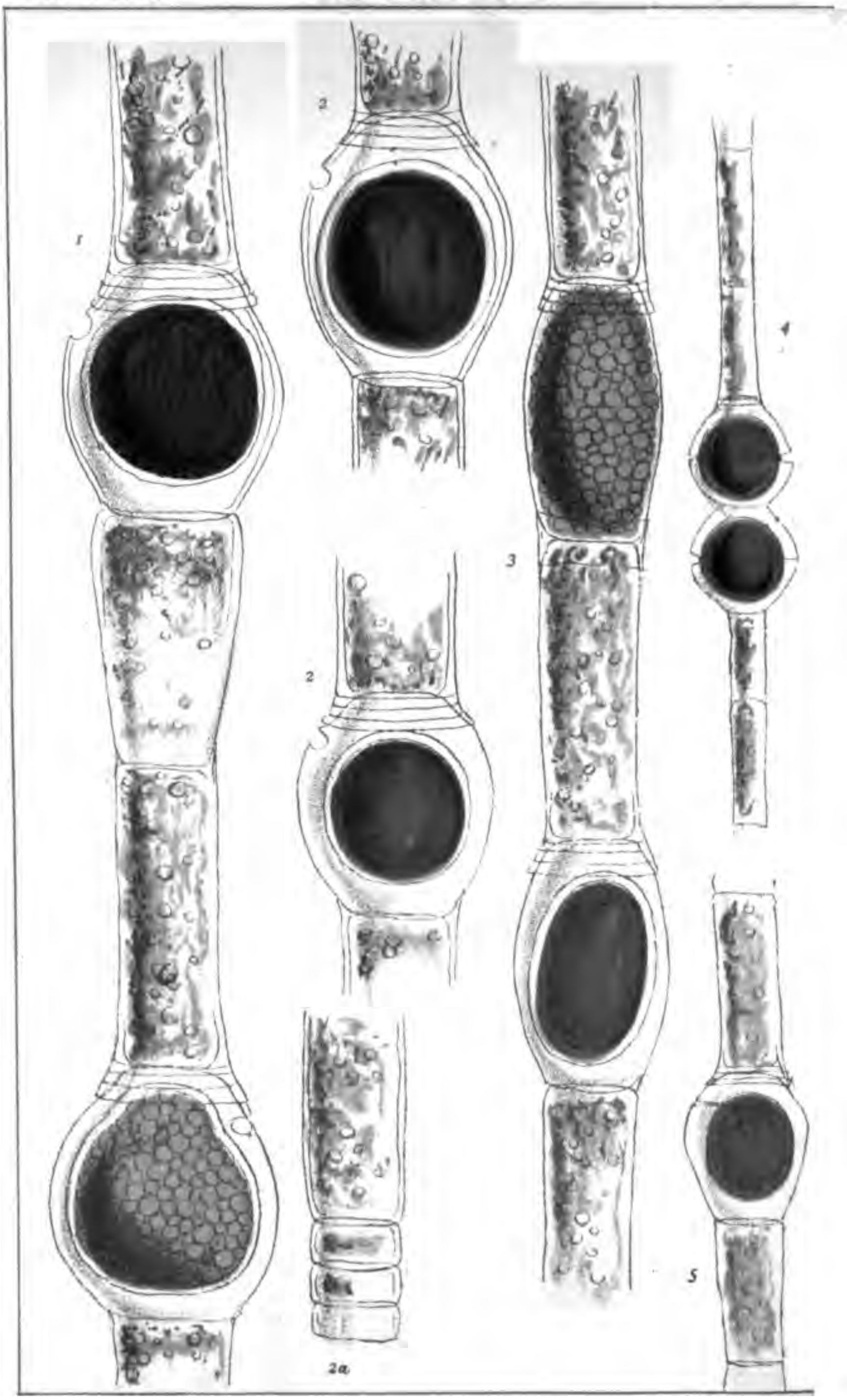
1. Œdog. crassum Hass. 2 Œdog. fasciatum. K. 3. Œdog: capilla
4. Œdog. grande. K. 5. Œdog. subsetaceum. K. 6. Œdog. tenel
7. Œdog. delicatulum K. 8. Œdog. hexagonum. K. 9. Bulbochæte



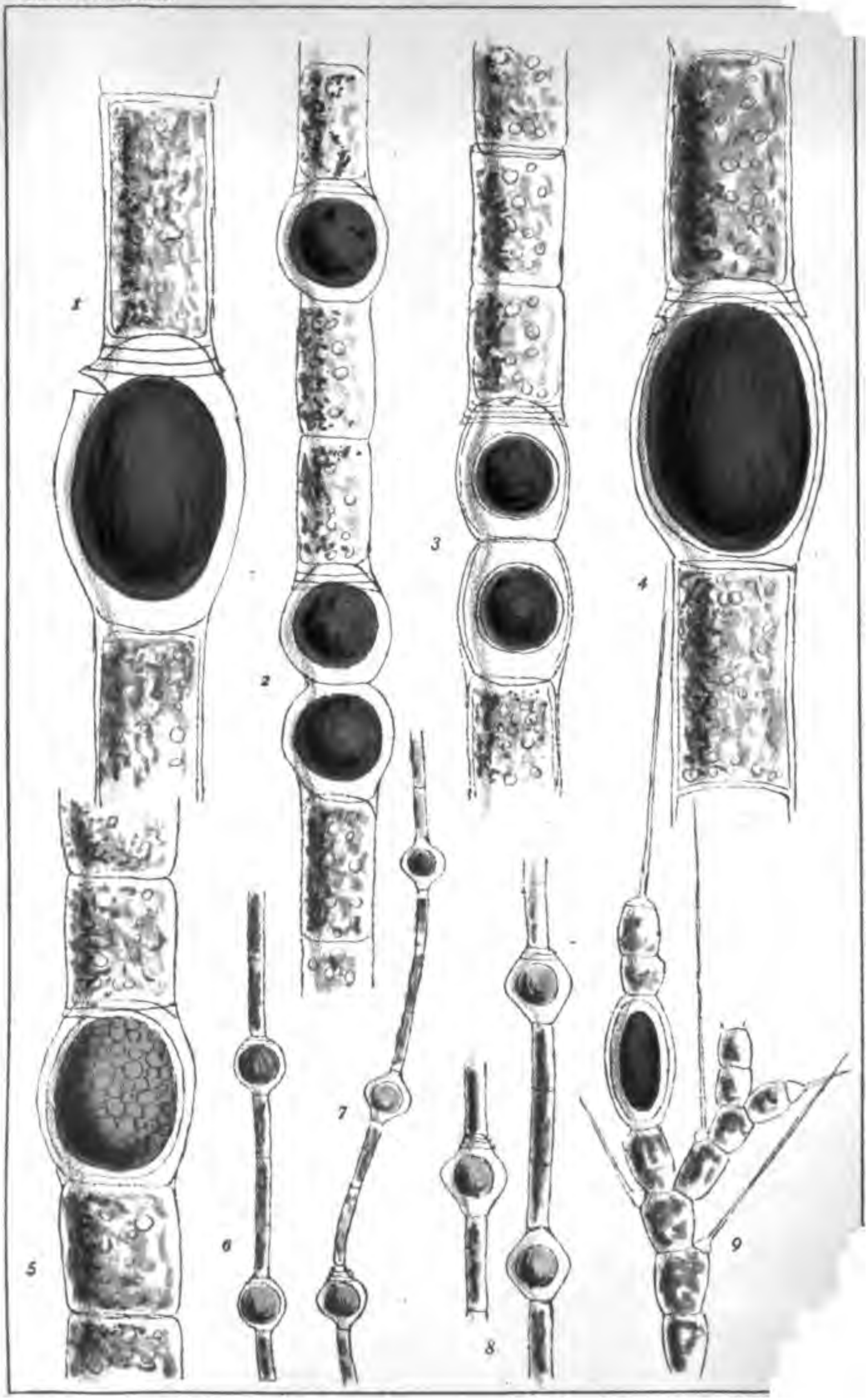
1. *Œdog. carbonicum.* W. 2. *Œdog. Pringsheimii* .W. 3. Œdog. punct
striatum. DBy. 4 *Œdog. Boscii* .W. 5. Œdog. tumidulum. Kü



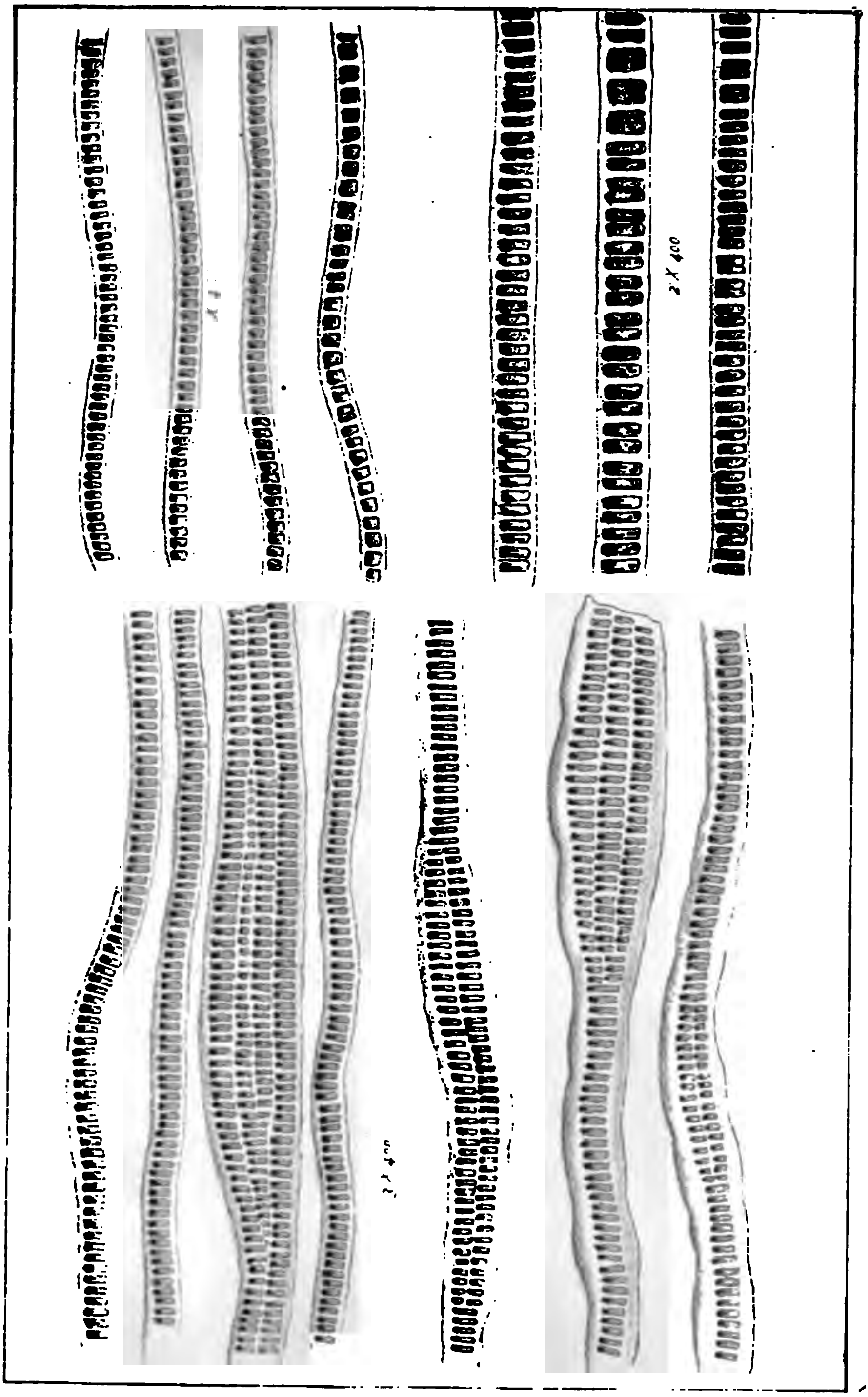
1. *Œdog. Landsboroughii. Hass.* 2. *variety gemelliparum.* Pr.
3. *Œdog. rivulare.* Br. 4 Œdog. longatum Kutz.



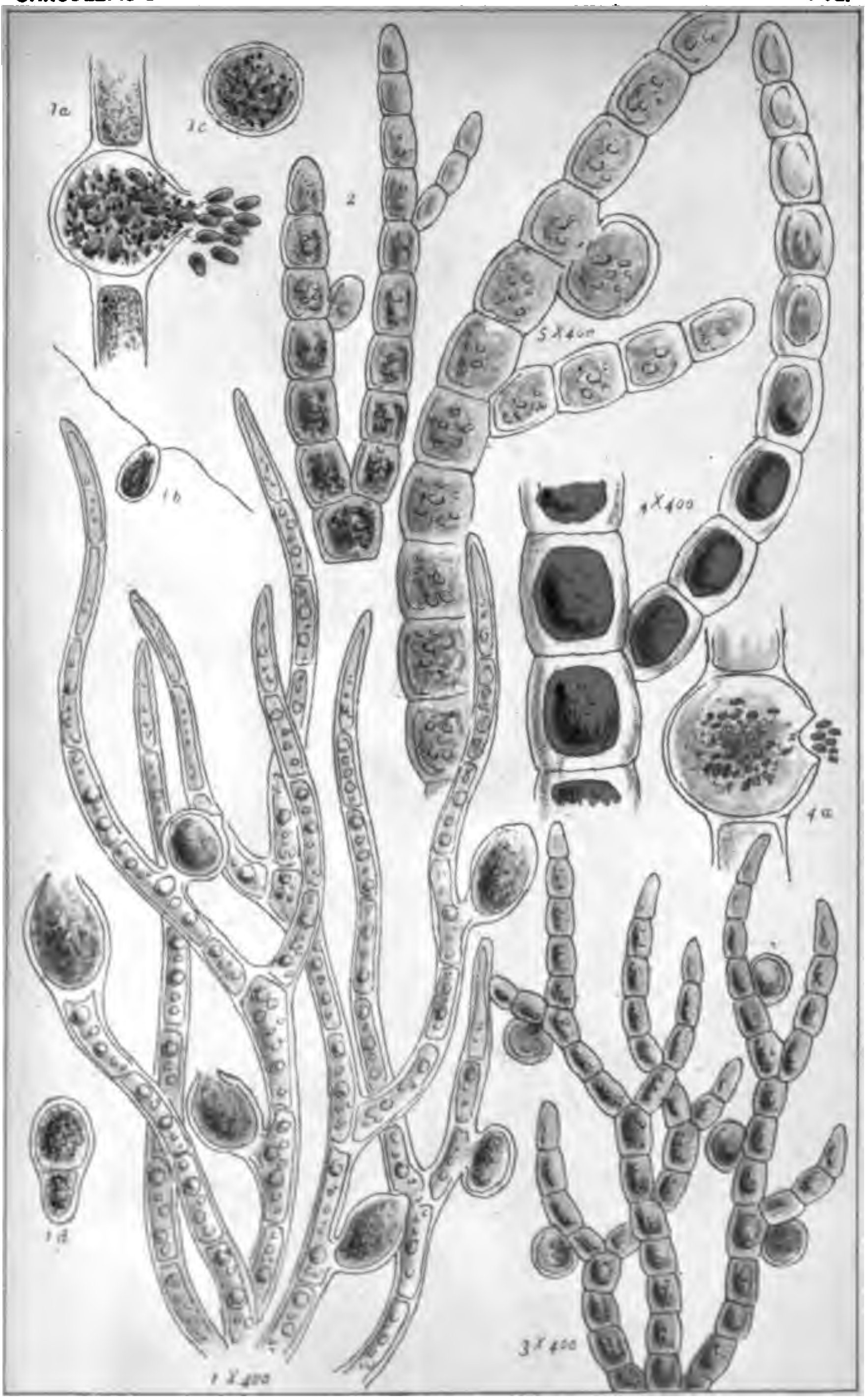
1. Œdog. Hutchinsiæ W. 2. Œdog. princeps Hass. 3. Œdog. giganteum
4. Œdog: Londinense. W. 5. Œdog. vesicatum. Lyngb.



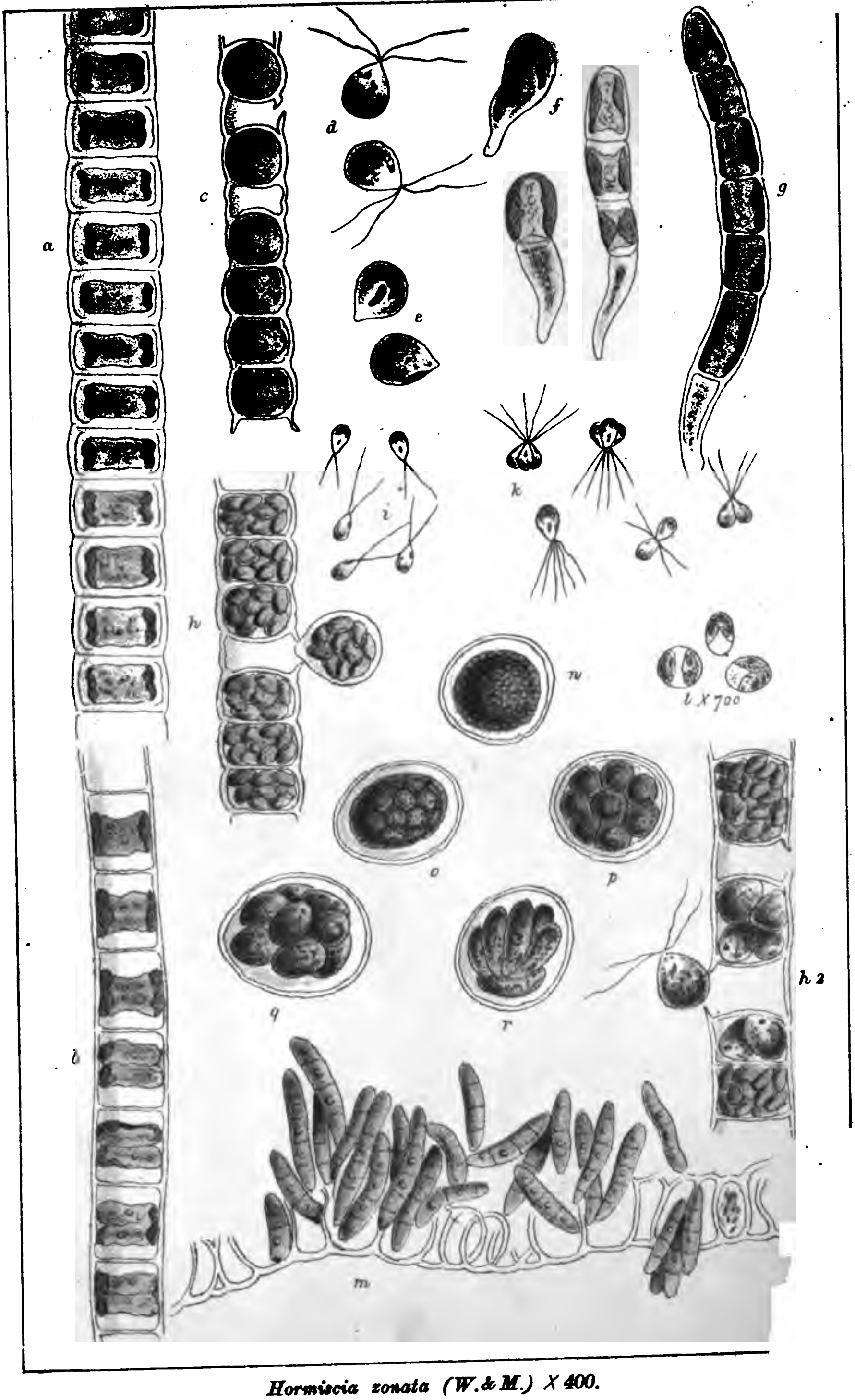
1. Œdog. crassum Hass. 2 Œdog. fasciatum. K. 3. Œdog: capilla
4. Œdog. grande. K. 5. Œdog. subsetaceum. K. 6. Œdog. tenel
7. Œdog. delicatulum K. 8. Œdog. hexagonum. K. 9. Bulboc



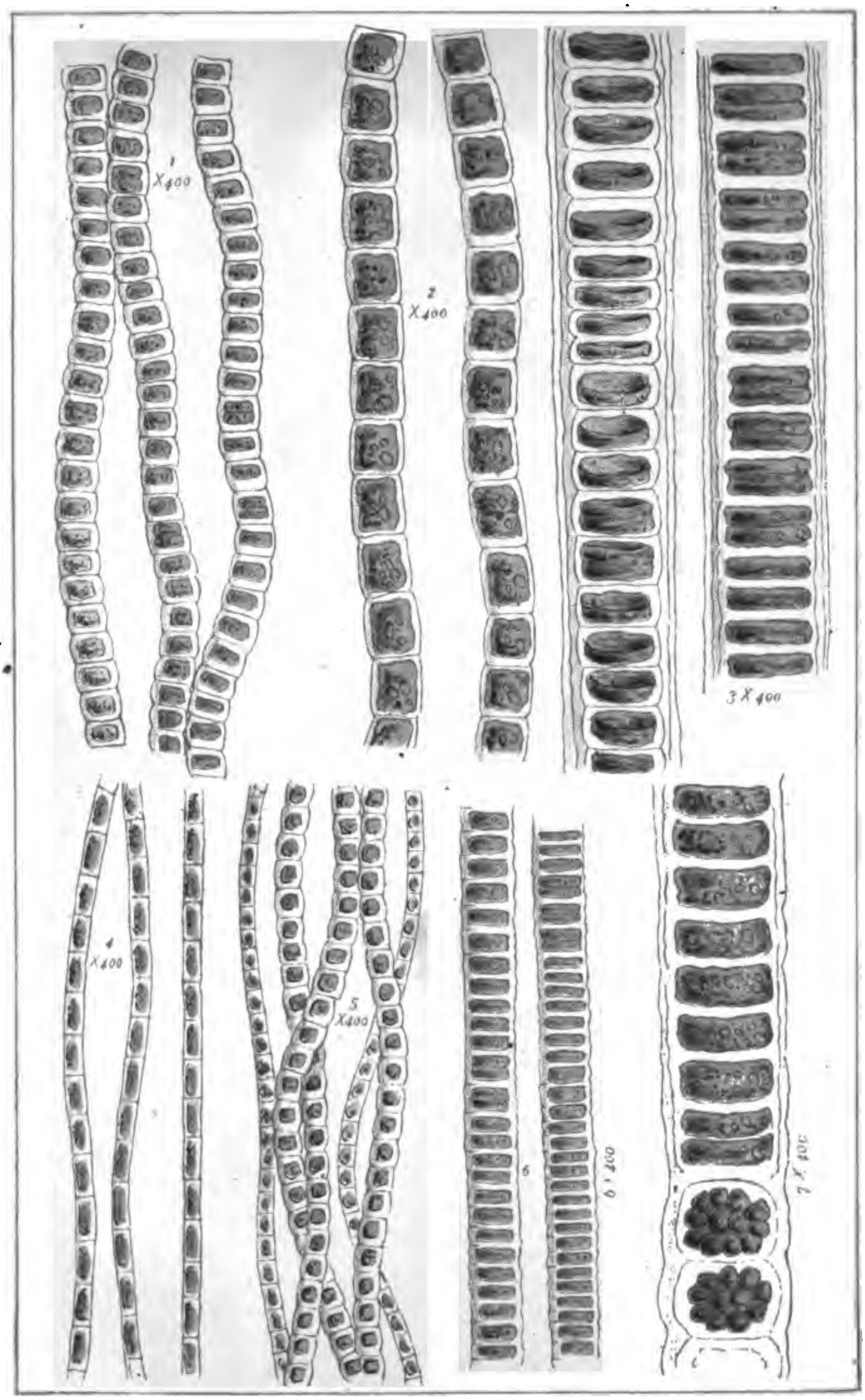
1. *Ulothrix radicans. Kutz.* 2. *Ulothrix parietina. Kutz.*
3. *Schizogonium murale. Kutz.*



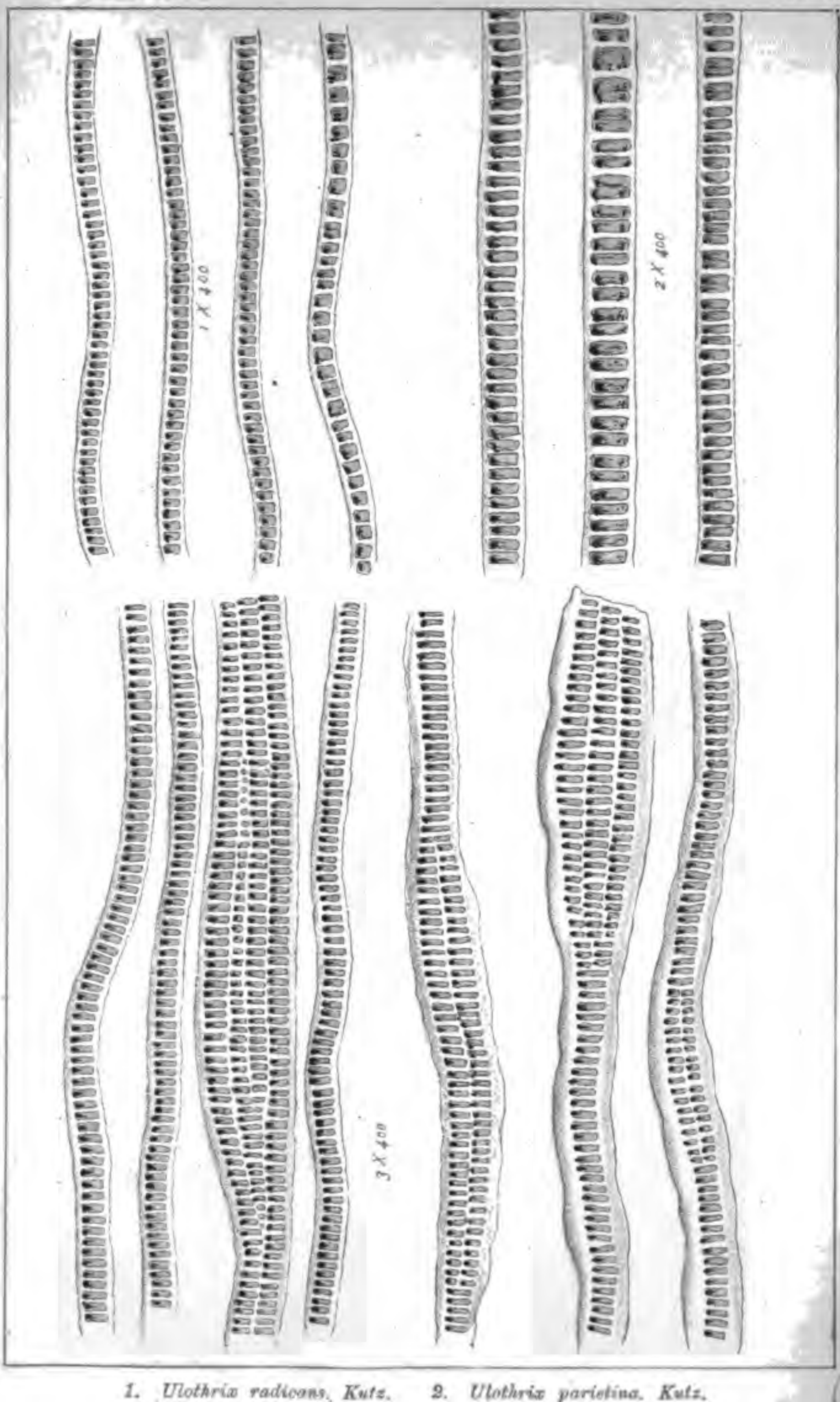
1. Chroolepus aureum. Linn. 2. Chroolepus odoratum. Ag. 3. Chroolepus abietinum var. lichenicolum 4. Chroolepus iolithus. Linn. 5. Chroolepus ilicicolum. H.



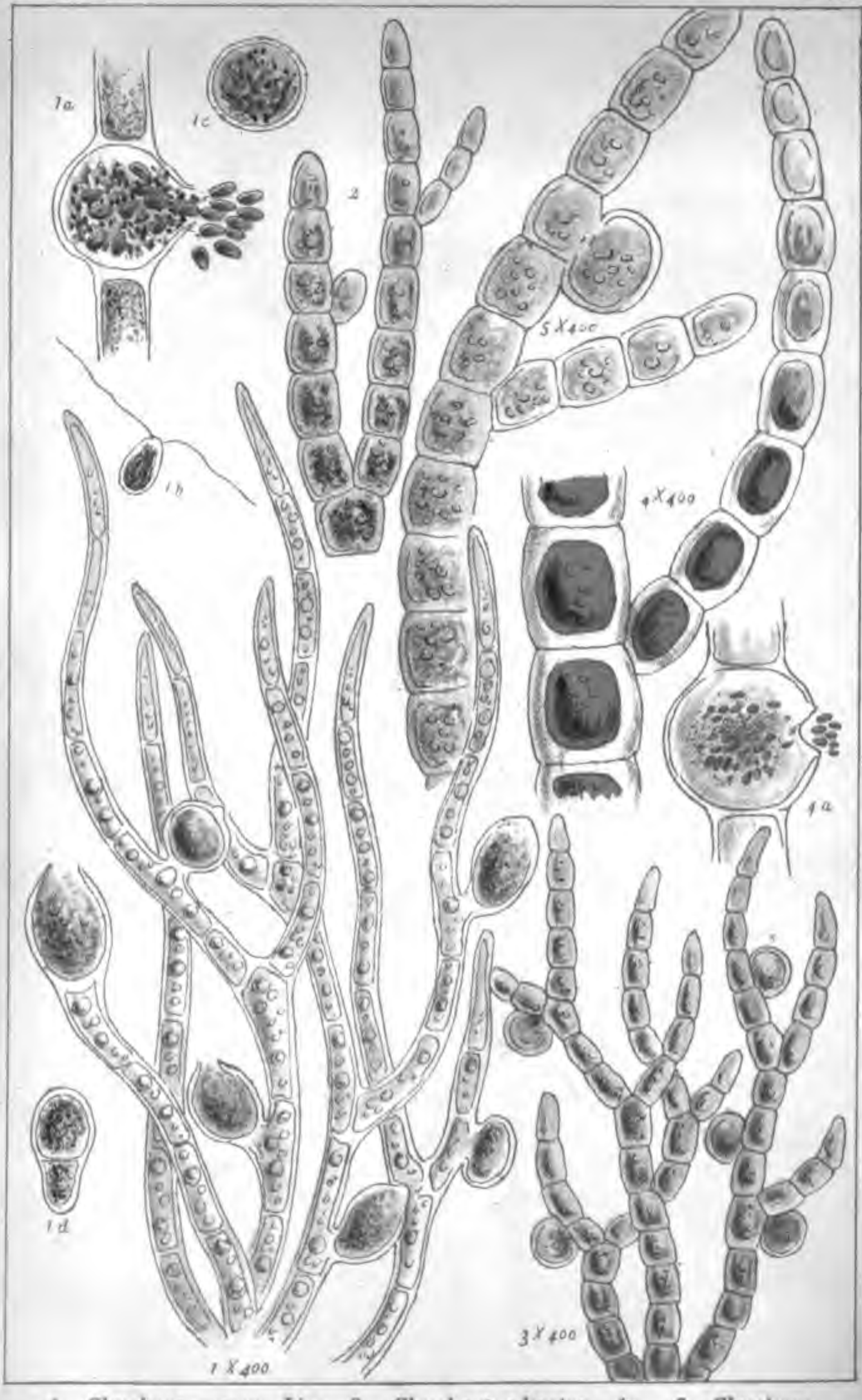
Hormiscia zonata (W. & M.) X 400.



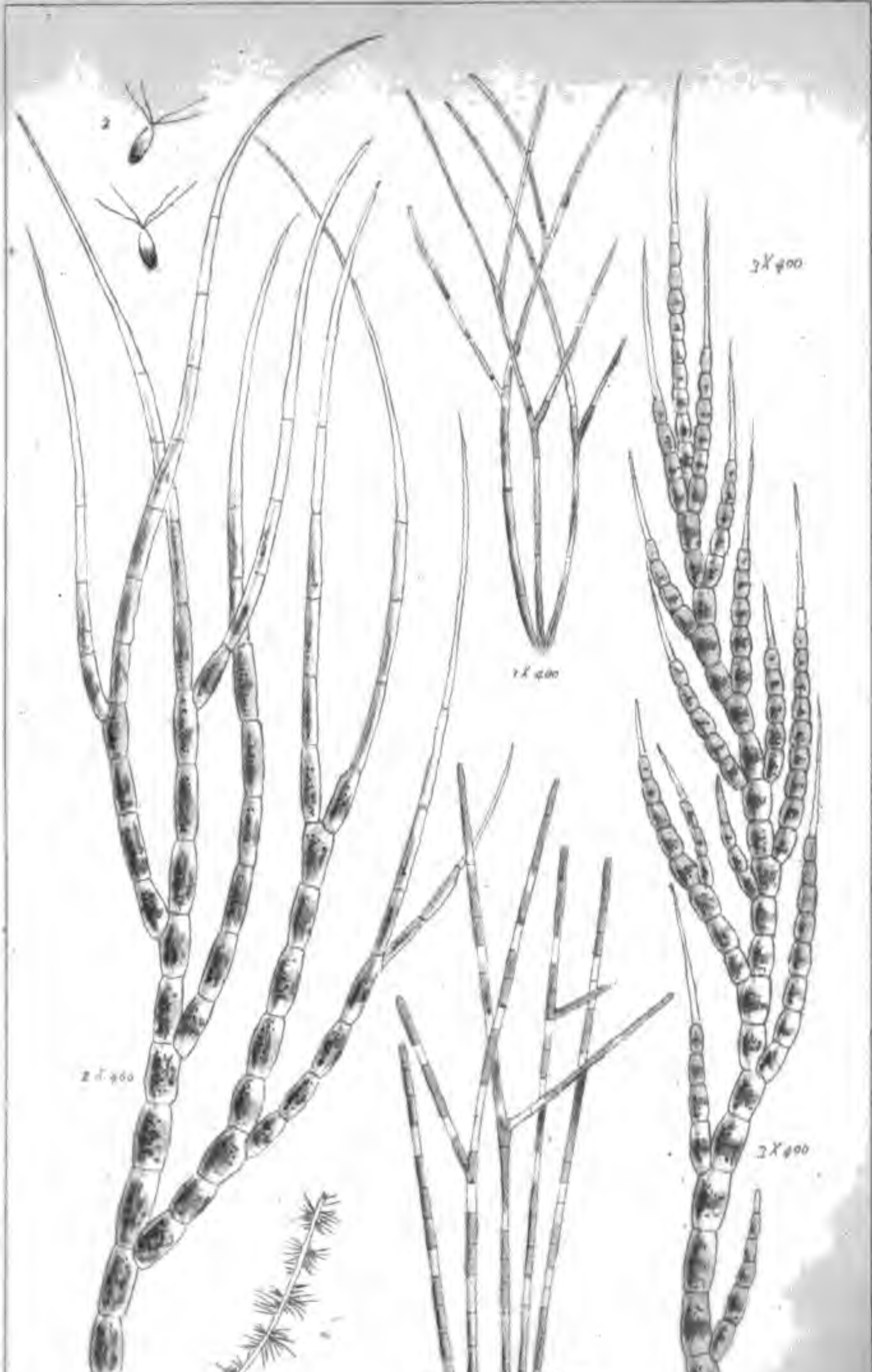
1. *Hormiscia moniliformis.* Kutz. 2. *Hormiscia catæniformis.* Kutz.
3 *Hormiscia speciosa (Carm)* 4 *Ulothrix variabilis.* Kutz.
5. *Ulothrix tenerrima.* Kutz. 6. *Ulothrix tenuis.* Kutz. 7. *Hormiscia bicolor.* F. B.



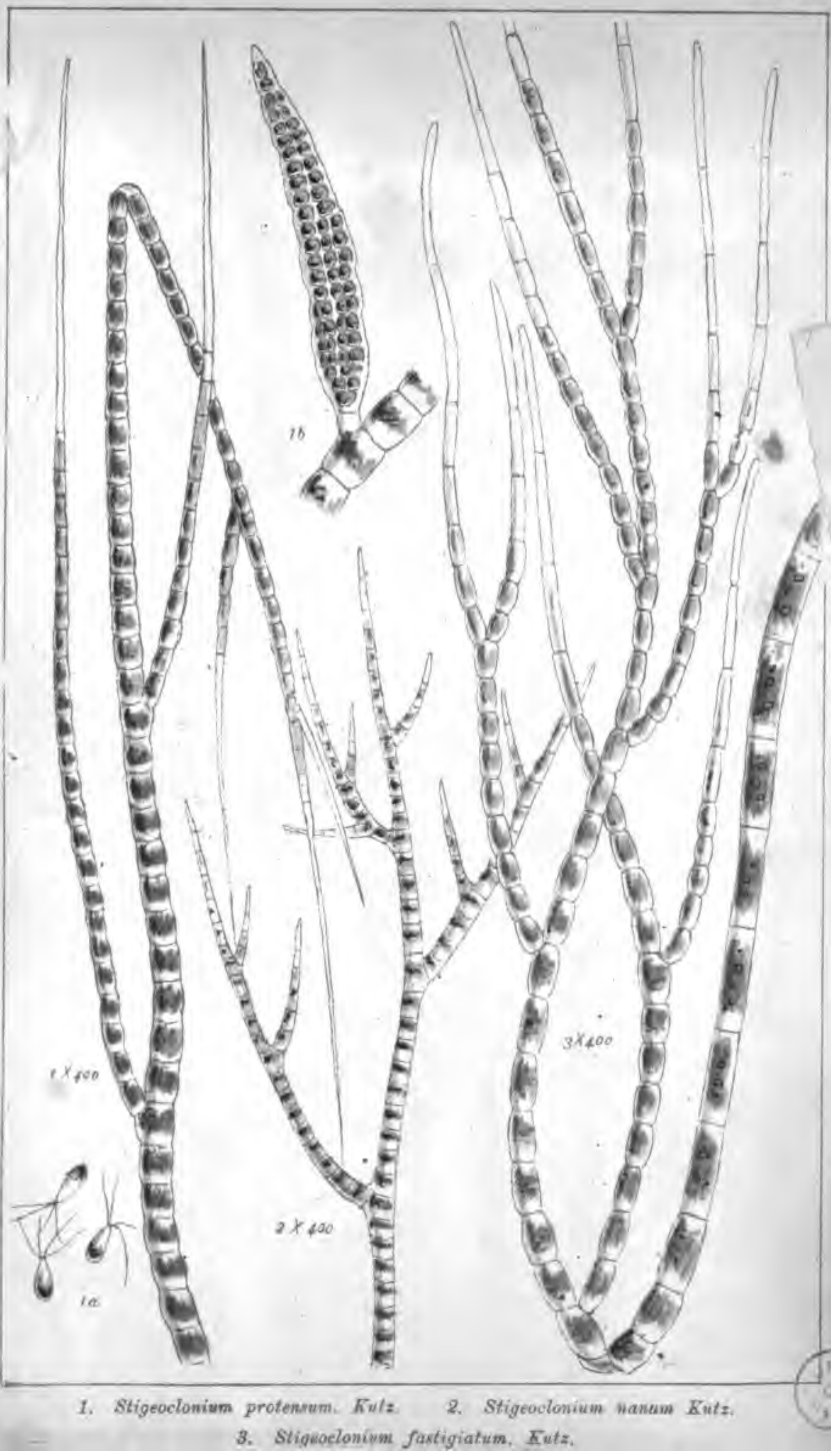
1. *Ulothrix radicans*, Kutz. 2. *Ulothrix parietina*, Kutz.
3. *Schizogonium murale*, Kutz.



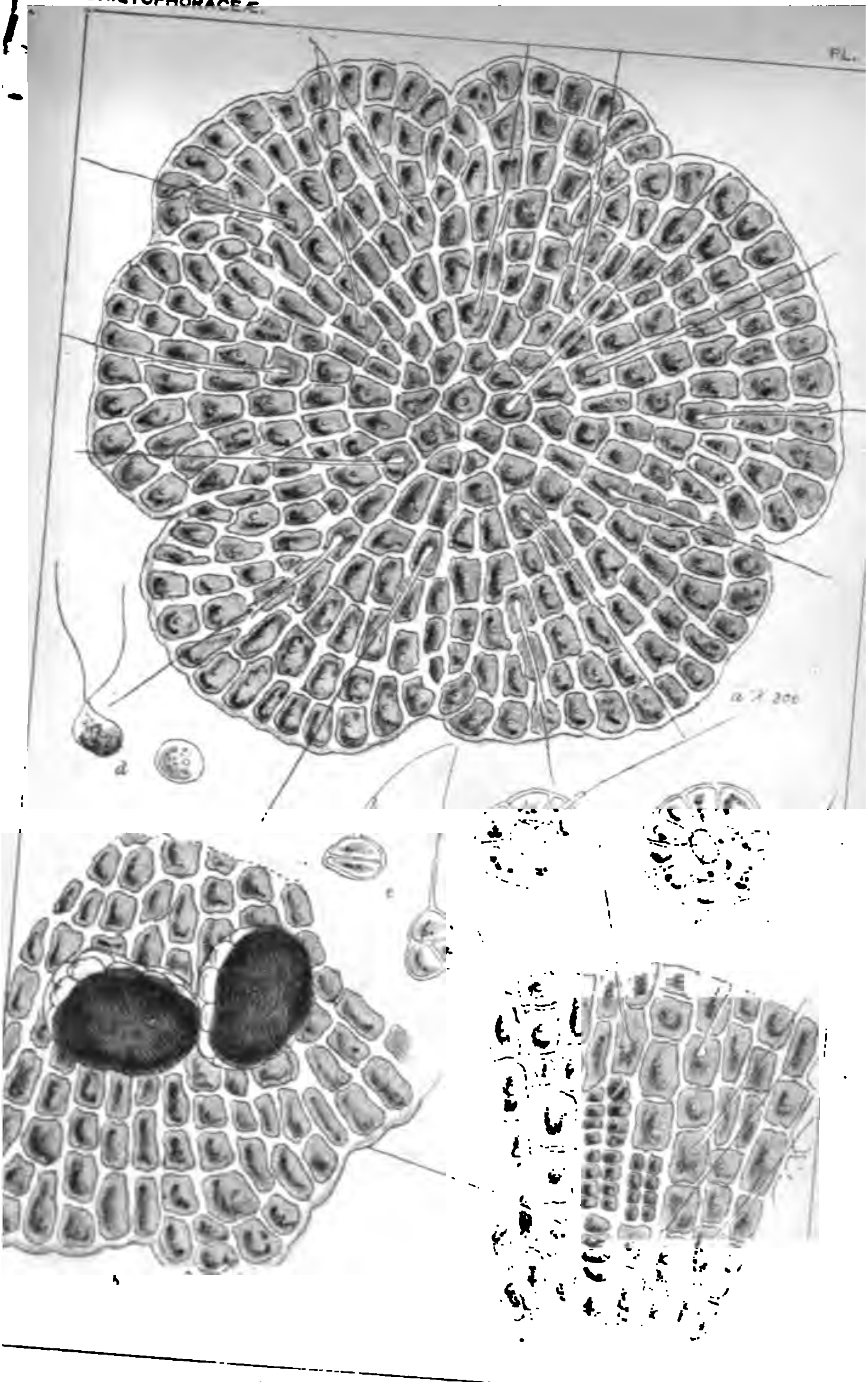
1. *Chroolepus aureum*. *Linn.* 2. *Chroolepus odoratum*. *Ag.* 3. *Chroolepus abietinum var. lichenicolum*. 4. *Chroolepus iolithus*. *Linn.* 5. *Chroolepus ilicicolum*. *H.*



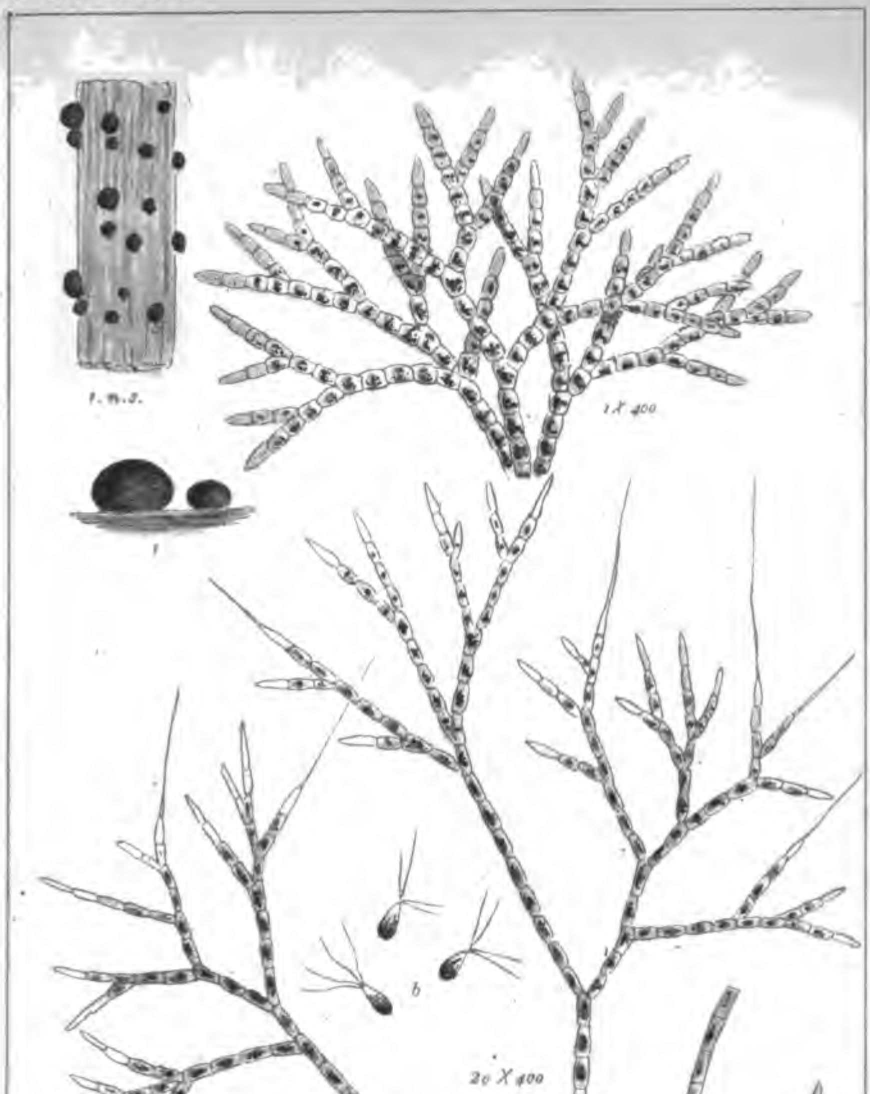
1. *Microthamnion vexator*. Cooke. 2 *Stigeoclonium thermale*. Br.
3 *Stigeoclonium tenue*. Ag.



1. *Stigeoclonium protensum. Kutz.* 2. *Stigeoclonium nanum Kutz.*
3. *Stigeoclonium fastigiatum. Kutz.*



Coleochæte scutata Bréb.



1. *Chætophora pisiformis. Ag.* 2 *Chætophora elegans. Ag.*

dicæfolia Ag.

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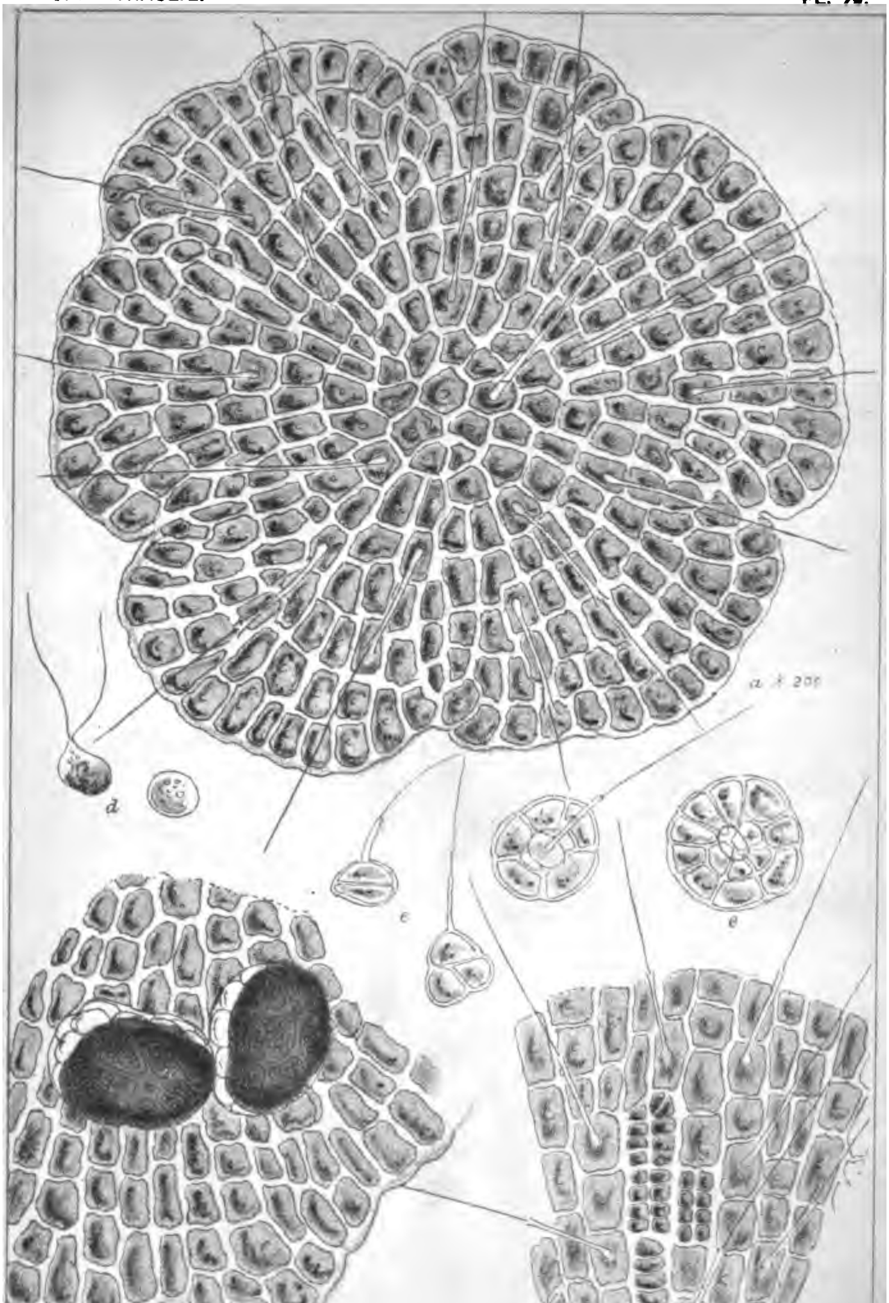

Coleochæte scutata. Breb.

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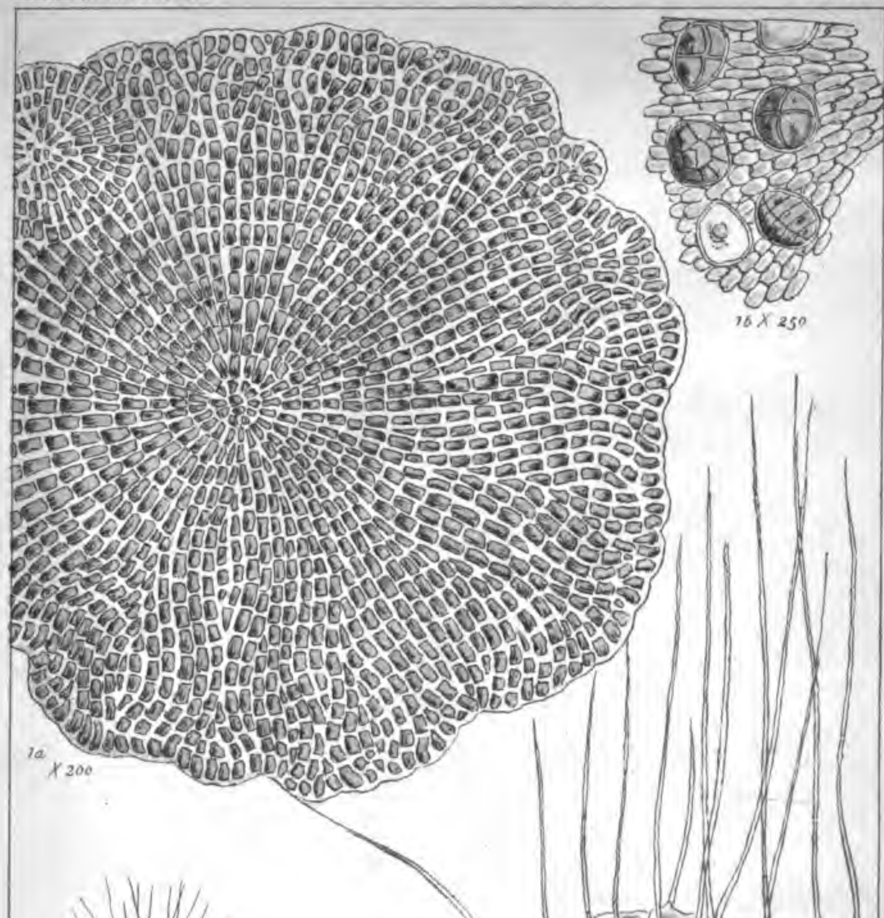

1. *Coleochæte orbicularis, Prings.* 2. *Aphanochæte hystrix, Thw.*
3. *Aphanochæte repens, Br.*

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